gatherings and will induce the attending companies to send a generous representation to the National Congress in Buffalo October second to fourth. I greatly regret that business obligations prevent my attendance at your meetings.

B. F. TILLSON.

I have one more announcement. You will notice from the program that there will be a public mass meeting this evening at the Shrine Auditorium. This will be a safety meeting and I would like all of you to attend if possible. Addresses will be given by Mr. Rasmussen, Mr. Fleming and other speakers. The safety exhibits will be worth seeing.

We are now ready to discuss Mr. Shove's paper.

MR. VICKERS—I was very much interested in both Mr. Hoarding's address and Mr. Shove's paper. I am especially interested in the safety-first movement. I am reminded of a story I heard one time about an old rooster. There was a rooster who had never been out of his hennery before. He finally took a notice to explore around the country a bit. He landed into a pen where there was nothing but geese. Seeing a large goose's egg there he was very much astonished, but finally grabbed it up and took it over to his hennery. He called his harem together and said, "I am not saying much, but just see what the other fellow is doing."

I think we ought to get around and see what other men are doing; otherwise we will become pretty much satisfied with ourselves and get a little stale. There has been a great deal done by way of improvement in the methods of mining ore and in educating miners. Ore is getting scarcer than it was years ago and instead of going in and taking all that is handy, we must use better methods to extract it. This makes us become more interested in the minor parts of the operation and we have to work harder to improve the working conditions of the miner. The compensation act is more strict, and if we don't look to cutting down disability we may be bankrupt.

MR. MARTINSON—I wonder if it has ever occurred to the men here that possibly in asking the doctors to cooperate in getting the men back to work, we are asking too much of them. Are we asking them to return men to work who are not fit? Are we getting men back to work who are not profitable to the employer? I think there are men here who have been successful in getting men back to work through the assistance of the mine physician. In starting this work a number of years ago we were told by the operators that they were not going to put anybody back on the job unless he could earn a day's wage, and we replied that the man can always earn a day's wage, or at least the difference between what he would get in compensation and the amount of his wages for the day.

Mr. Pellenz, who has been doing remarkable work the last six months in getting men back to work, can probably tell us whether it has been profitable.

MR. PELLENZ—I was very much interested to hear the paper by Mr. Shove in regard to cooperation and before I explain the benefits of getting men back to work in the modern organization, I would like to mention something that I think should be coupled with cooperation. The first six months of 1923, as Mr. Hearding stated, we had lost time due to accidental injuries amounting to 25 days. We were quite surprised ourselves. When we checked back in 1922 we found that for a like period we had lost 2,265 days. In looking for an answer our committee concluded, after a good many stormy sessions, that there were two things responsible for that. The first was sincerity and the second cooperation. Now, I want to go into details a little on what I mean by sincerity. I remember the time when we had committees appointed for sixty and ninety-day periods. The safety engineer would come and ask for a man and the first thing I would think of was whom I could spare, and I would probably pick out somebody whom I could get along without. The organization was mighty keen to see that and you could not blame them. We had safety meetings of foremen. When it came to a question of operating to save costs, when the shovel had a guard off, the engine broken foot boards, it was a case of fix it when you get the time. Don't take the time. The organization knew that we were not sincere in our safety work. I can tell you a number of things along the same line. When we were told that we were members of the District Safety Committee with the idea of cutting the lost time injuries and to forget the costs, that is just what we did, and when the men saw that we meant to be sincere, it didn't take but a month or two for them to get wise to that. We had their cooperation, and we have been successful in getting them back. I think we have one man at the Spruce on crutches, who is taking the place of a man who would have to be there. He goes down into the mine in the cage and takes the chips, and he does it just as well as a man who is well. We may have stretched a point, but I do not believe it. We have made a good showing, but we are not always going to be so fortunate. For instance, we had a bad accident yesterday afternoon. The old story of a hot hole. The blaster was loading a second hole and had three sticks of 40 per cent ready and was putting in the fourth leaning over the hole and the charge went off.

To sum it up, the operator must be sincere, and that soon gets to the men and when it gets to the men and they really know the operator is sincere each man takes on the responsibility of taking care of himself, and also feels that he owes it to the other fellow, and when you have an accident each man starts to check himself up to see if he has been negligent. There is the responsibility upon the men themselves and they accept it, and when you get that spirit I want to tell you that you have the thing beaten.

DISCUSSION.

MR. MARTINSON—I think that sincerity is probably just as important as cooperation. Has anyone else something to say along this line?

MR. REED—There is one phase I thought worth while mentioning. A fellow was going down the street one day with a violin on his arm and he met a friend. The friend said, "Can you play a violin?" He answered, "I have not tried yet." Well, there is a lot more to playing a violin than trying one.

There is one thing about a football team that strikes me. You don't get a football team by catching a group of boys on the street and telling them to go down to the back lot as you have a game to play with some neighboring team. There is a lot of painstaking work to be done by the players and the coach before they can play a good game. The more experienced ones tell the less experienced ones how to play and the boys soon learn the meaning of how to cooperate. The coach doesn't stand on the sidelines and bark at the men either; when he wants a play made a certain way he takes the place of the men in the line and goes through it. He shows him how to play. And from this it seems to me that in order to cooperate you have to do the thing yourselves, or be able to do it, and show that it can be done. I was struck with what Mr. Pellenz said when he stated he was trying to do this work in an easy way, but when they came to put effort and thought into it they began to get results. So you cannot get anything by just asking for it, you have to go after it, and I think this business of working together is one of the best ways of accomplishing results.

I remember years ago I was with the New York office of one of the big mining companies and they sent me down to New Jersey. I had not been there very long before a man was killed on a locomotive crane in one of the yards. I found on investigation that the man had just started to work on the crane that morning. The fireman did not show up and the foreman of the gang went to the man and told him to go over and fire Number 7 locomotive crane, and before night he had been killed. Now, nobody told him anything about what to do, or how to take care of himself, and nobody even asked him if he had any experience on the locomotive crane before. The first diagnosis I made on the job was that the foreman had more men to take care of than he could. This man was told to go on the job without any coaching or training as to how he ought to handle it. A great deal of the loss of life of men on the job is due to not giving' them any training. If we want to get cooperation we will have to make an effort to get it. A man cannot cooperate with the other men on the job unless he knows his own job.

MR. KEOWN—Where the management is absolutely behind the accident prevention work you will find the whole organization is very much more alive to it than in a plant where the management is indifferent. Go to a place where the management is not sold on accident prevention and the same prevails right down through the superintendent and the foremen to the men. You can't expect anything else. You cannot expect the workers to value safety work and the prevention of accidents when the head of the organization scoffs at it, or doesn't put himself out to push the thing along. If the foreman knows that he is going to be held responsible for the accidents in his department he is more apt to be more careful and look after the safety of those under him. I know a number of plants in Wisconsin where the management are too busy to pay any attention to accident prevention and you can very well judge what their accident experience is going to be.

SAFETY IN ELECTRICAL INSTALLATIONS IN MINES.

By F. C. Stanford, Chief Electrician, The Cleveland-Cliffs Iron Company, Ishpeming, Mich.

It is a great privilege, gentlemen, for me to appear before you this afternoon—an unusual opportunity for me. I am not in the habit of addressing gatherings of this kind. I have had to do largely with practical applications. I wondered as I sat in the gathering this morning if it were possible that we were theorizing too much and overlooking the more practical things. By profession I am an electrical engineer, I am interested in perfect constructions and perfect maintenance of electrical applications as applied to mining. I am not directly interested, in the event of an accident, as to whether the man who is unfortunate returns quickly to work or not. I am vitally interested, however, in preventing that accident. It seems to me that is the essential thing.

It is entirely possible that the paper which I will present to you will appear somewhat more technical than those which you have had. If I could gather the safety inspectors and safety engineers around me in an informal way I should like to quiz them and learn their way of determining whether a condition is safe or is not safe; whether an installation is properly installed or properly maintained so that an accident could not occur. But there are too many of us to attempt a meeting like that. I wish to be understood that I should like a reasonable discussion of the paper, because while I have tried to present a matter which is naturally more or less technical in a thoroughly practical way there may be points that are not clear.

The subject of safety in electrical installations in mines is of value and interest to those practically and technically trained who are responsible for the safety of the property and the welfare of the employees in the metal mining industry. This paper is not primarily for the information of the technically trained electrical engineer. The reasons for certain general practices in the manufacture, installation and maintenance of electrical equipment may be found in the publications of the American Institute of Electrical Engineers and in reports of joint committees of

the A. I. E. E. and A. I. of M. & M. E., and National Electric Code.

There is nothing in the installation of electric wires and apparatus in mines which necessarily involves a high degree of specalized training in order that there may be no excessive fire hazard or danger to employees. The use of electricity for the transmission of power is now so common, and the fundamentals so well understood, that, in common with other construction and maintenance work, we have a right to expect absolute safety. However, electricity is such a willing servant and is so ready to perform the things which we expect, even under improper or unsafe conditions, that there are times when we are likely to be negligent if the output tonnage is not unfavorably affected.

There is a fundamental rule that should always be observed in making electrical installations in and about the mines. This rule should be observed no matter what the service; whether lighting, signal or power applications. This rule is very short and very simple:

Never allow any temporary work to be done. Always consider that the installation is likely to be permanent and insist that it be made in a workmanlike manner.

There is no other way whereby we may prevent what our men are pleased to call “hay wire stuff.” The reason for this rule must be obvious to all safety engineers because they know that the probability of accident to men, or the danger from fire, is always increased manyfold during construction or temporary installations. Practically the only difference in cost between permanent work and “hay wire” is the difference between the labor cost for a competent man and the labor cost of one that is incompetent. The material cost is practically the same in either case, while the temporary job will have a salvage value as junk only and the well constructed should have a high salvage value.

There has been a rather general opinion among some people that the hazard of any electrical installation increases with the increase in potential; that no, 220 or 440 volts is safer than 2200 or higher voltage. Speaking in a general way, this is not true; in fact, with proper installation and application we are inclined to believe the contrary is the better view. The heating effects of current in a given conductor are in proportion to the volume of the current. It is more difficult to design and maintain apparatus for the control and rupture of large current than of small current values within reasonable voltage limits. It is more difficult and expensive to put in large conductors than small ones, and the amount of inflammable insulating material on the larger conductors is greater than on the smaller ones. About the hottest thing we know is an electric arc such as is used in welding, and this is at low potential because of the greater stability of the arc. At the higher potential you might have a bigger flash, but the probability of a sustained arc is less than at a lower potential. Unless gas is present a flash will not ordinarily start a fire, while a sustained arc will burn almost anything. These assume, of course, that circuits are protected in the usual manner. We have not hesitated to use up to 2300 volts in the mines for hoists, fans and pumps, and have found this to be reliable and safe.

It is my opinion, based upon a rather extended experience, that no electrical installation or extension should be made until it has first been ordered or approved by the best electrician or electrical engineer available, and that he should be held responsible for the proper application and safety of the installation. Much time and effort is necessary to prevent serious hazard to employees and apparatus due to the overloading of transformers, wires, motors and generators. Operating executives, as a rule, are so closely concerned in the details of producing high output at minimum cost that they have no time to enter into the details of electric applications. As an illustration, I heard of an executive recently who wished to use a direct current motor, which happened to be available, for some power application. This motor when connected happened to run into the wrong direction and the executive stated as this was a D. C. motor of course it could not be changed, so he made a mechanical connection to give the proper rotation, not taking the time to listen to the local mine electrician or calling upon the district foreman or engineer. This, of course, was not a reflection upon the ability of the executive, although he had a dozen D. C. locomotives working at the time which were reversed many times each day. This does illustrate the difficulty that even techncial men may have in seeing clear through an application about which they may have only a general knowledge. It is a very common custom to add lights and heating devices to circuits from time to time, as convenience dictates, with no thought whatever as to the capacity of the wires that supply the service, and to order additional motors for some temporary or permanent service with no consideration as to the load that the transformers may have that must carry this additional load. While it is no doubt true that the transformers and circuits are probably protected with fuses, it would be an unusually able and strong minded mine electrician who would not, under pressure of the demand for service, over-fuse the line or take a chance that the circuit will carry the additional load for a little time until it could be straightened out.

In mine service I find no reason to allow any work on live lines. The circuit under repair should always be dead, and the switch plainly marked as “Open and Men Working on Line.”

In general, installations of electrical surface equipment do not differ from general power and lighting of other industries in any important respect. This apparatus should conform to the code in every detail. It adds somewhat to the reliability and safety of the installation if the principal applications are divided as to circuits, with the circuits distributed from a common switching point. In the event of necessary repairs, the circuit affected can be cut off and the switch tagged while repairs are under way and the remainder of the plant continue in

operation. There has been a tendency in the past few years to favor truck style panel switch boards and on the larger units to use remote control. These features are desirable and add to the reliability and safety to a considerable degree, without adding appreciably to the cost. Surface wiring should all be in conduit or armored cable on account of the greater safety from fire hazard and our experience has proven quite conclusively that in the long run this is cheaper than open wiring. For all voltages above 1000 the code requirement that lead covered wires be used should be adhered to. If conduit is used then conduit outlets are required, and if cables are installed some form of potheads at the terminals is required. The rule requiring that conduit, cable sheath and armor must be grounded should be very carefully adhered to and inspectors should see that this rule is followed. Wherever practical, a reliable circuit breaker is much more satisfactory than fuses, and in general I am inclined to require circuit breakers for all power applications and heating devices, limiting the use of fuses to lighting circuits only. In addition to the more reliable protection to circuits and apparatus we then have the increased protection to the men when they simply close the breaker instead of replacing fuses. If continuity of service is an object then there is no argument in favor of the fuse.

Wiring at the switchboards should be carefully installed and frequently inspected. At this point the protective covering of wires is removed and a certain amount of the wiring will of necessity be somewhat exposed to fire hazard. The use of asbestos tape for protection of wires here is advisable, and a fire extinguisher of pyrene or similar type, should always be near at hand. If the truck type panels are not used then protective screens or some other method to safeguard employees from accidental contact will of course be installed. Oil circuit breakers must be inspected frequently to determine the condition of the oil and contacts, and the present practice of requiring an inspection after a breaker opens under a short circuit before it is allowed again in service is a good one. Circuit breaker supports and switchboard frames must be well grounded.

Care used in the location of rheostats and grid resistances lessens the fire hazard, and the rule that flame proof wire be used for connecting these must be adhered to always. Contactor panels must be so placed that the flash will not cause a fire hazard or burns or injury to the eyes of the men when in operation.

All motor frames, transformers and compensator cases must be grounded.

In the operation of electric hoists it is of course essential that some form of safety device be used for protection in the event of overtravel, overspeed or less of power. There are several devices on the market which are entirely satisfactory. When making an inspection of these, see that the wiring is in perfect conditioned when you observe the operation determine in your mind whether you would feel safe if you were on the cage at this time, and if you think you would then approve of the apparatus, otherwise it should be condemned. It is attached for the protection of the men and equipment, and if it does not do this it is valueless. We advise lead and armored wires for the connecting of this apparatus if the wiring is carried outside the building for connecting to shaft limit switches or otherwise. Inside wiring may be in conduit. The recommendation for all conduit work I think may be very properly applied to all lighting work in buildings which are of a permanent nature, and possibly to all light wiring except perhaps surface lighting outside the buildings.

In the plats, pump houses and fan installations require all conduit or armored leaded cables. See that the frames of apparatus are well grounded. Use automatic control wherever possible in order to keep the men as far from the dangerous potentials as can be done, and also to eliminate to a degree the personal element where we are likely to depend upon more or less indifferent workmen. Make the electricians maintain as high a standard of excellence in their work underground as on surface. Don't allow temporary work. Check the fan installations particularly, because of the draft the fire hazard is much increased. Do not have the draft draw wet air from the mine through the motor. See that all fan motors are protected against overload, under voltage and short circuits by circuit breakers. Do not depend upon fuses here, because sometimes a miner will put a wire across instead of going to get a fuse to replace one that is gone. When a D. C. motor is used, see that the low voltage release on the starter is not tied over. This is a very common occurrence and you can never find out who did it.

In haulage installations, don't waste time inspecting locomotives if these are in trouble. The hazard is not increased. Only output is jeopardized. Look at every trolly hanger to see that it is in good condition, and that the trolly does not come in contact with timbering. Where the trolly is in crushing drifts, insist that an automatic trolly switch be installed which will cut off the current when the locomotive comes out. Do not allow exposed switches and see that the switch mountings are so arranged that a loose terminal can not start a fire. Do not allow sloppy wiring for lights. See that the light wires are put in so that they cannot touch any timbering.

The best way to determine the safety of the electrical work done by the electrician is to see whether it is neatly done in a workmanlike manner. This shows whether he is careful or not and whether he is interested. If the work looks bad condemn it on general principles. See that fire extinguishers are available near every switchboard and important motor installation. As often as possible the chief inspector and electricians should make joint inspections of electrical equipment. This will enable the safety inspector to give the electrician pointers as to modern practices and allow the electrician to relieve himself of his pet grievance. Continual and systematic inspections and reports are the only method for correcting and maintaining the standards necessary for the maximum safety in electrical installations in mines.

Shaft cables are now well standardized and are readily obtainable. These should all be lead covered and armored. Under no circumstances should open wiring be allowed. I would not approve the use of either metal or fibre conduit in the shaft. This is because of the additional inflammable material when fibre is used, and the difficulty of properly supporting the conductors in long vertical runs with any kind of conduit unless openings are left at frequent intervals in the conduit run. The tendency to require bore hole installations is all right and probably reduces hazard from fire in many installations. Personally I think that a properly made cable put in the shaft in a workmanlike manner is entirely safe, and I see no reason for bore hole cables in metal mines unless conditions differ radically from those with which I am familiar. In our own mines we have standardized on two sizes of A. C. shaft cables. For small power applications with no probability of increase we use a number 6 three-conductor, and for the larger installations number 00 three-conductor, both insulated with varnished cambric for 3000 volts service with lead sheath and steel wire armor of sufficient size to support the entire weight of cable. If additional capacity is required another cable is installed. The armor and lead sheath must he carefully grounded and the cable terminated each end in porcelain terminal pot heads wiped to the lead sheath. We have usually provided jute serving over the armor to indicate an electric cable, but are now inclined to leave this off as it is more or less inflammable and is probably not now required. When making installations great care must be used not to drop the cable. We always clamp it to a hoisting rope at frequent intervals and lower from the surface with the regular hoist. For D. C. cables we are using a concentric cable with stranded copper inner conductor insulated for 600 volts and lead covered, and an outer conductor of alternate strands of copper and steel with sufficient steel to carry the weight and enough copper to give a conductivity equal to the inner conductor. The outer conductor armor is of course the grounded rail connection. We have never had a failure with either of these types of cable.

For signal and telephone service we are using 600 volt multi-conductor cables lead covered and armored. These terminate through potheads in junction boxes at each service point and connections are made to telephones, bells and ringers through two or three conductor lead covered armored conductors. We usually carry m this cable one pair of light wires and connect one or two lights on each plat so that there may be light at the shaft if the other sources of supply fail. We endeavor to make all the signal wiring as nearly waterproof as possible and have the construction perfect. It has been found that in addition to the added safety because of reliable signals, that our maintenance has been practically eliminated. From the viewpoint of safety it seems to me that the signals and telephones cannot be too carefully installed, and that we are fully justified in spending any necessary amount winch will add to the reliability of this service. In the deeper mines high capacity ringer switches should be used on account of the capacity effect in the long cables. An oil immersed switch is the best for these installations.

In the installation of power units underground in mines, such as pumps, fans, haulage, winze hoists, etc., we have been inclined to think that these require an unusually high order of technical skill and practical ability in order that they may be safe and reliable. I think that the installations in packing house refrigerating plants and on street railways, all of which were carefully worked out before we put motors underground, require just as great a degree of ability and the requirements are just as exacting. Apply the same rules and safeguards and insist upon just as high a standard of workmanship as in the plants which are in public view and your service will be just as safe underground as in your home.

DISCUSSION.

MR. MARTINSON—I had the opportunity to read Mr. Stanford's paper before Mr. Stanford read it today, and it has occurred to me that we are having each year more fan installations underground, and it seems to me that is a great fire hazard. I should like to know how big an area around the installation should be protected.

MR. CONIBEAR—If a fan station is not in a rock drift it should be made fireproof at least eight or more feet each side. Guniting may be used for this purpose and it is very satisfactory. The installation of the ventilating equipment of the Cleveland-Cliffs Iron Company has been made in accordance with the recommendations of the U. S. Bureau of Mine's engineers.

MR. MARTINSON—I would like to ask a question in regard to the towers, which are erected where the transformers are. I notice our employees climb the towers to change fuses or something, and usually they have trouble when there is an electric storm. It has occurred to me that we have a rule that a platform over four feet high should have a railing around it. The towers are usually 18 or 20 feet high. Is it practical to put a platform around them?

MR. STANFORD—Generally speaking I would say no. With trained men—linemen for instance—railings are an objection. The lineman of the present day who works on high voltage apparatus usually wears a safety belt. In order to facilitate the work and get into position the less apparatus you have the better for the man. He is less likely to get into trouble. There are several things to consider in getting close to high voltage lines. When the direct current was in general use, if a man came in contact with the current he could not let go, but now with the alternating current it throws him away, and in the event of an unusual condition and he does get in contact it is better that he should be thrown clear than not to be able to get out. We don't allow any railings on our installations. We feel it is much better that he be thrown away from it. I should be inclined to hesitate somewhat in recommending the use of guard rails. Another reason is that the tendency is that some man who is not familiar with that kind of apparatus might go up and attempt to fix

it, and I should hesitate to put guard rails in the places you mention. However, it is a question that would have to be decided by the particular installation. We carry the high tension circuit directly to the transformer. The probability that the transformer will burn out is rather remote. We put the circuit breaker on the ground and for that reason it is a rather remote case where the man should have to go up on the tower.

MR. MARTINSON—In some of our underground installations a wire is run from a trolley wire over to a post, a socket or lamp is attached and the wire is carried to the ground. Is there any danger in spiking the wire on the post?

MR. STANFORD—Supposing that post is wet and the ground wire breaks what is going to happen?

MR. HENDRICKS—All the lines are protected by the posts. We put them in behind the post so that there is no danger, if they are properly fastened, of their being broken.

MR. STANFORD—That would be all right. However, I guess you could get enough current through to leak into the timber. The timber is the only inflammable thing, if you can get enough current through.

MR. HENDRICKS—The conditions are such that it is almost impossible to get it on the knobs. That is the idea of putting it in behind the post.

MR. STANFORD—Don't you think it would be better to put a piece of conduit around the post?

MR. HENDRICKS—That is what we do where it is possible.

MR. STANFORD—You understand that we electrical men are much in the same position that the safety inspector is. We are only school teachers and we are trying to teach the operating man what is the best practice, and while we are doing that we occasionally learn a little ourselves. That is the standard way of connecting lines. It is absolutely safe if the ground wire cannot be broken. I presume it is the unusual condition which causes the hazard, and we are gradually changing these ground wires wherever possible, either by putting in a very heavy wire—that is a section of an old piece of trolley wire 0 or 00—or by using a piece of conduit. We are really going to an extreme but the general good requires that the ground wire be properly protected and that is only a protection against the unusual thing which might occur. We are not condemning the old practice and are assuming it is all right. I notice now they are condemning things where there was not any fire just because they think under some unusual condition there might be a possibility of one, and we are like all the rest. We are trying to better the thing the same as the safety men—trying to catch up, but we try to lead the way if we can.

STATE ACCIDENT PREVENTION WORK.

By D. R. Henderson, Chief of the Accident Prevention Division of the Industrial Commission of Labor, of Minnesota, St. Paul, Minn.

The duty to protect and look after the moral and physical welfare of the worker in any capacity has been conferred upon the state, both in Minnesota and other states in the Union.

During the past ten years each session of the Minnesota Legislature has passed labor laws to protect the worker, and today labor is super-protected in many ways, such as: wages, hours of labor, working conditions, medical care and. compensation after accidents. To enforce these labor laws of Minnesota and thus allow labor to reap the full benefits a Commission was created by the legislators, known as the Industrial Commission of Minnesota, and upon its shoulders rests the duty to help workers secure all privileges to which they are entitled and at the same time to see to it that employers of labor get fair and impartial treatment.

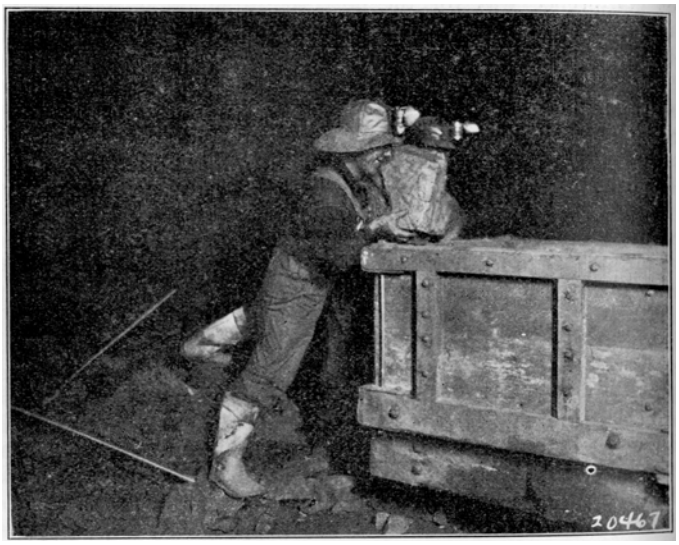
It was not long with the operation of the state law before it was discovered that each stale inspector has a system of his own, thus causing recommendations to be issued which were conflicting. State inspectors had to have a foundation to work on. After considerable thought and discussion, the Commissioners decided to call a conference during September, 1922, at which conference employers, employees and insurance companies were represented. This conference was for the purpose of adopting some sort of standard code of safe-guarding to be used by all safety inspectors in the State of Minnesota, and thus create uniformity when making inspections. As a result of this conference, these standards sponsored and adopted by the National Safety Council are being used by safety inspectors in their work. These national standards are the standards used in most of the states of the Union, and it so happens that many employers of labor have plants in many states in the Union and by standardization of all the states it is better for the employer than if each state had a standard of its own.

State inspectors try to impress employers of labor with the idea that only perpetual vigilance and efforts on the part of employers and their representatives, in educating their employees in habits of safety can make them careful of their own lives and limbs. If this spirit is non-existent in industrial plants, all guarding is a waste of time, material and money. The prevention of an accident is a better way to help the worker than to compensate him after the accident has happened. So-called compensation is only a tendering of the helping hand but no monetary consideration can ever repay in full the suffering, both physical and mental, caused by a serious accident to the worker. It has been well and truthfully stated, "That to prevent an accident is a benefaction. To pay compensation is simply an apology." Realizing this, the Accident Prevention

Division of the Commission has bent and is bending all its efforts and using every means at its disposal to prevent the occurrence of an industrial accident.

According to the records of the Commission, accidents can be divided into two classes: those that are preventable; those that are due to uncontrollable causes, these causes being part of the industries in which accidents happen. Ninety-five per cent of all accidents are preventable, their cause being the carelessness of somebody. There is where accident prevention science has its greatest battle to fight—eliminating carelessness and destroying the false sense of security in the minds of employers, foremen and workers of the ranks and file of industry. This accomplished, and 95 per cent of the accidents will not occur. This is an easy thing to say, but not so easy to accomplish. Only continuous pounding and repetition by safety engineers on the value and means of avoiding accidents can permanently establish the habit of safety and self-preservation in the imperfect human brain.

Bearing this in mind, the state safety inspectors, when surveying industrial plants in Minnesota, use persuasion and appeal to reason as a means to secure the elimination of dangerous conditions found by them rather than threats of court action or use of other drastic measures allowed by law. I don't know whether you know it or not, but a state inspector can seal up a plant if he sees fit, and this is a thing which we hate to do. As a matter of fact, in the past year we have only employed this method twice and we have made over 28,000 inspections. These are only resorted to in extreme cases and only when all other methods to secure safety have failed.



ONE CAUSE OF ACCIDENTS.

The results obtained by this method of persuasion have been very gratifying. From July 1, 1922, to June 30, 1923, inspectors of the Industrial Commission made 28,882 inspections and offered 10,768 recommendations covering defects found in plants. Up to August 1st, 95 per cent of these were reported as complied with, and this without a single court prosecution.

Safety work must be organized. This can only be accomplished through safety organizations. The efficient safety organization starts at the top—the owner or manager of the plant must be sold to the idea of safety. He must believe in safety himself, and in turn convert all those under him to his faith of safety. A safety organization without an enthusiastic management back of it is a failure. Too many organizations are started with the sole purpose of securing a reduction in insurance rates. Such an organization is a deception not only on employees but on employers themselves, as such reductions in insurance rates are fictitious and only exist on paper.

An employer who goes ahead and provides safeguards to protect his employees from accidents and who makes an effort to inculcate into their minds the necessity of using safe methods in going about their work, because he believes it is right and proper, shows the proper spirit, and his accidents will be few and far apart, as compared with the employer who does those things for the reason that he feels he has to and that the law requires it. The former is a valuable man to society and an unwavering and devoted friend of humanity, while the latter is a distinct menace to both.

WHY MINERS SHOULD KEEP COOL.

By Thomas T. Read, Supervising Mining Engineer, U. S. Bureau of Mines, Duluth, Minn.

When people do something new it nearly always happens that effects are produced that neither they nor anyone else expected. This has been true of most great inventions, and is especially true of the automobile. The automobile has made necessary our modern system of good roads, made it possible for people who live in remote places to easily and quickly get to centers of population, and generally speaking, it has revolutionized living conditions in rural America, as well as creating a very serious traffic problem in our cities, but the point I want to make now is that the automobile has made practically everybody familiar with the principles and operations of an internal combustion engine. We should have known all about internal combustion engines, because each one of us is provided with one when we are born, but our own internal combustion engine is self-regulating and also has the power of repairing itself so that it was not essential for us to pay much attention to it, and also we got it free. When a man pays for an internal combustion engine as he does in an automobile, he is more likely to give it attention and besides, if an automobile engine does not work properly someone has to fix it, because it can not fix itself. As a result people have had to learn how to take care of internal combustion engines and that results in the general

public getting a better understanding of how to take care of themselves.

All internal combustion engines develop excess heat and have to be cooled. The amount of heat they develop is proportional to the speed at which they are running. In an automotive engine this cooling is provided by a radiator, which gives off the heat brought to it from the engine by circulating water. In the summer if the engine runs fast it does not get enough cooling and the radiator is likely to boil, while in the winter it gets too much cooling, and you have to close off part of the radiator. Very much the same thing happens to us and in winter we have to keep ourselves from getting cooled too much by putting on extra clothing, while in summer we often get overheated even though our internal combustion engine is doing its best to cool itself. Our bodies are cooled in the same way as the automobile engine, but we have an additional method of cooling that is largely self-adjusting, namely, cooling by sweating. You may not know that the ordinary person is being cooled by the evaporation of water from his body at ordinary temperatures. It is only when water is coming out on the skin so fast that you can see it in visible drops that we speak of sweating, but as a matter of fact, a person is being cooled by the evaporation of water, even though there is no visible sweat on them. Sweat, indeed, may be said to represent faulty working of the cooling device, because if drops of sweat fall off without evaporating, they have not done their work of cooling.

The amount of energy that goes into this cooling of the body is really quite large. Everybody knows how unenergetic they feel in hot weather and this is because so much of their strength, is going into the work of trying to cool themselves. That is the principal reason the countries of the world that have hot climates do not amount to very much as compared with the countries in cool climates. The people there do not have enough energy to accomplish much. The white man in the tropics seldom does anything except boss the natives and he does not get much work out of them, partly because they can not do much work in a hot climate, and also because under such conditions he is not a good boss. When a person gets overheated his energies are over-taxed and he loses the power to think clearly and quickly. His mind is sluggish and he becomes irritable.

In one of his books Luther Gulick described a bicycle race that he took part in that illustrates this very well. At the beginning of the race he fastened a watch to the handle bars so he could estimate how fast he was going and so regulate his speed. At first he was able to do this, but as he began to get overheated and tired he found that he could no longer make the mental calculations, although he could still read time on the watch. Later, as he got more tired and heated he found he could not tell the time, although he could see the watch. Later still, he found that lie could not even see the watch, although he was still able to keep the bicycle going. When people are overheated they can still do mechanical tilings, but they don't use their heads as well and if they get much overheated their ability to do mechanical work also falls off a good deal.

The first reason why a miner should keep cool is, therefore, that his mind does not work as well when he is overheated as when he is kept cool, nor does it act so quickly and he is more likely to be the victim of an accident. The second reason is that overheating very much interferes with his output. He has only so much energy and if a large part of it is spent by him in trying to keep cool through sweating, he will have less left to exert at the end of a shovel or pick. We know by exact measurement that if the wet-bulb temperature gets above 85° F, a miner can do very little work. From the standpoint of mine output it ought to be recognized that it is essential to keep miners cool so that they can do a fair day's work.

The third reason is that a wise manager wants his miners to be comfortable. Some years ago it was not so generally recognized as it is now that it pays to give a man good tools to work with and good conditions to work under. With wages as high as they are now it is poor business to let a man work under poor conditions.

Fortunately it. is not very difficult to keep miners cool in this district, because the mean annual temperature is rather low and all you have to do is to set up an air circulation by fans and the working places will be cool. It is only where heat is being released by the decay of wood that you need much cooling power and it is not very difficult or very expensive on the average, to see that a proper air circulation is set up in all working places.

I might, by a play of words, also argue that a miner ought to keep cool in the sense of not losing his head and getting excited in an emergency. Failure to keep cool in this way is a very common source of accidents, but I am not now talking about that kind of keeping cool, for I want to emphasize the ordinary kind in the normal sense of the word, namely, that it is good business and profitable to keep the miner physically cool. To summarize there are three good reasons why a miner should keep cool: (1) He can use his head better and work to better advantage; (2) He can exert more energy in his work, and (3) He is more comfortable in doing his work and not only does a better day's work, but is better satisfied. All these are reasons that are of just as much, importance to the management as they are to the individual miner and they have a safety significance as well, because the miner who keeps cool is less likely to be injured in an accident.

MR. MARTINSON—Last year we had on our program a very interesting paper on ventilation. The Safety Council was criticised in some quarters because safety engineers had the audacity to consider ventilation. My reply to this criticism was that we do not care who considered it if we could arouse the mining managers to improve the conditions in the mines as regards ventilation. I know that some companies have gone to

considerable expense to better the conditions of the men at the mines. I believe that the Eveleth District of the Oliver Iron Mining Company made the first installation on the Range. Possibly some of the men here may have had some experience with the installation of ventilating equipment that will benefit the men who are in doubt on this question.

MR. VICTOR—A couple of years ago we had stale air in our main shaft and we found that the mine was not opened up properly to get proper ventilation from the one main fan on surface. This was due to having a heavy mat of timber overburden generating heat. It got to a point where the men could not work in several of the dead ends of drifts and we either had to relieve this condition some way or shut up the mine. So we tried out booster fans, transmitting the air to points underground and feeding it to the main. There are places where we are boosting air 1,000 feet, and we have kept operating. As a matter of fact we have boosted our fans to put in clean air to the working places where they could not get it otherwise.

MR. PELLENZ—There is one big thing that is pretty hard to reckon and that is the lengthening of the life of the miner. Before we installed the fan at the Fayal—and we have a 35,000-foot fan —during the summer time there were 12 or 15 gangs that we could not work at all, and after the fan was installed we have not-had a place but what we could work. I don't know how you are going to figure that in dollars and cents but the main thing is that you are lengthening the lives of the men. We tried to figure it out and I think that we saved five cents per ton, so you can see that there is a saving in furnishing good air to the men and keeping the places all operating.

MR. HAGERSON—When the subject of ventilation was discussed last year after the paper was read I sat near Mr. Shove and he wanted me to say something about the Newport and the Anvil mines. At the Newport we have installed a 75,000-foot fan and at the Anvil a 50,000-foot fan. I found at the time they sunk the Woodbury shaft—we had the Dee shaft and the Bonnie shaft, one downcast and the other upcast—that the Woodbury shaft was so large we couldn't get a current of air to circulate. They thought at first of getting the air down the Dee and Bonnie shafts, but the Dee shaft gradually began to fill in and there was not sufficient air going down. They put in doors and tried forcing the air from the subs in the raises, but it didn't work, so they put a fan at the bottom of the Dee and tried to suck the air down. This was not satisfactory, so they moved it back and put it on the 19th level. It was some 1,400 feet from the shaft, at the bottom of a raise, and it pulls the air down the raises and forces it up the shaft. About two weeks ago it was moved from the 19th level and put in the 21st level, in granite, and all of the bad air from the different subs is pulled down the raise and forced over to the Woodbury shaft. The same is true at the Anvil, but about two years ago it was found that it was advisable to change the direction of the air so we moved the fan back from the Number 2 Anvil shaft to the Palm shaft. That was done for the reason that cold air, of course, requires a smaller space than when it becomes warm and expands. The volume of air that goes down the Palm shaft could not be more than the Anvil, which was smaller.

MR. MARTINSON—I wish Dr. Read would tell the men here about the service which the Bureau of Mines is willing to give the operators on the regulation of air and recommendations for improvement.

DR. READ—I was just ready to get up and tell you men about that service when the Chairman called on me. I guess everybody here knows that the Bureau of Mines is a national service bureau. It was created for the purpose of being a service bureau, and helping the operators with many of their problems. It is a service bureau and that is all it is. We cannot make you give us any information, and we cannot make you submit to having your mines surveyed and examined by our engineers. And that is the way we want it, because if we cannot work in cooperation with the mining industry then we are no good. Now, we want to work in cooperation with the mining industry. On this ventilation work Mr. Harrington is our man. He is the one who is most familiar with the subject of ventilation, but all our district engineers have worked under his direction and are willing to serve any time you are willing to have them do so. If you have a problem that you think the Bureau of Mines can do for you, all you have to do is to ask us and we will get the engineers to work on it. We have made several investigations in this district and made reports to the mining companies and give them the experience we have obtained from this district and from other districts. The problem of ventilation in this district is relatively simple to some places where the conditions are very bad. We are willing to make a survey and report on the property any time you want us to. We have no club and cannot make you put in ventilation unless you want to, but usually we can show that it is worth while. The latest case I heard of the other day was where the mine operators could not get enough miners to maintain an output, and they put in a ventilation system and the men came back to work. Therefore, it was not only good business but it made the men comfortable and satisfied. We are like the doctor, we come when we are called, and any information that is given the Bureau is strictly confidential. We don't publish any figures about your mine and we don't use this as a means to get information about the mine. We are strictly a service bureau.

MR. PELLENZ—What sort of tubing does Mr. Harrington recommend?

DR. READ—I have seen cases where people have absolutely given up sheet metal tubing on the ground that they could not stop the leaks and it was expensive, and they have used vent pipe. The people who have used vent pipe usually said it was fine, and got a good delivery at the end. Mr. Harrington could answer that question far better than I, because he has worked on the

practical side of the question not only in this district but in other districts of the United States as well.

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UNLOADING AND SAMPLING ORE AT LOWER LAKE PORTS.

By *C. P. McCormack and †C. C. Walsh.

The discharge and sampling of iron ore cargoes at the Lower Lake ports are important performances in the train of operations, carrying the ore from exploration to finished products. It is the fair meeting point of seller and buyer, where the true character and analysis of the shipment are best determined. At this stage the ore is well mixed—in proper furnace shape—and is the result of the complicated mining, grading and sampling operations of the miner. On the basis of this condition the ore is paid for, hence it is a vital step to both consumer and producer and should be thoroughly understood by them.

Aside from the method, actual taking and chemical determination of the sample—all of which are standardized and successfully performed—the loading and unloading of the cargo are interwoven agencies having noticeable bearing on the sampling results obtained.

Ore carriers are of one general type, ranging in carrying capacity of from 3,000 to 14,000 tons. Hatches equally spaced, with either 12-foot or 24-foot centers, over the entire cargo deck, open directly into the three or more compartments dividing the hold of the vessel. The cargo space is thus three or more open rooms, enclosed by flit floor and smooth vertical walls, and allowing rapid filling and discharge of burden.

The ore, pouring into the hold through spouts leading from the dock pockets, builds up in cones under each hatch. As each average 12-foot center hatch will hold roughly 300 tons, representing 7 railroad cars, the layers of ore radiating: from, the apex of the cone will be composed of different grades of ores unless the 7 cars are exactly alike. Since each dock pocket ordinarily contains 5 cars, a full hatch load is made up from more than one pocket or filling of that pocket and the cone layers may vary materially. In 24-foot center boats each hatch is filled to capacity, while usually in the 12-foot centers every other hatch is coned up higher, due to the final trimming: of the vessel. Between the high cones, or heavy hatches, is then a lower intersection, which in 12-foot centers is called the light hatch. When a vessel carries more than one grade the separate ores are loaded into different compartments.

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†In charge of sampling for Crowell & Murray, Cleveland, Ohio.

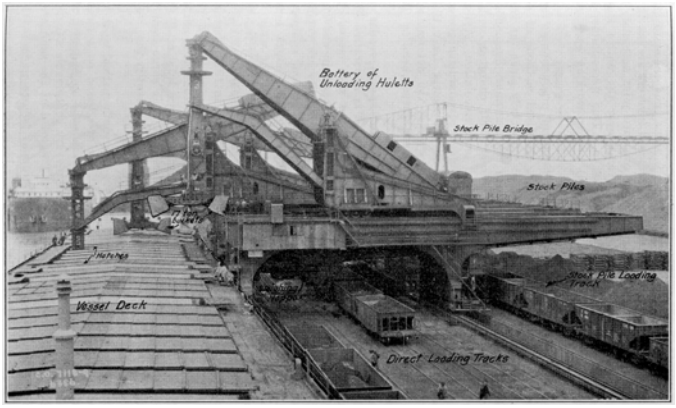
Guarantees of season's shipments are made from the grading of one or more ores into a specific single ore. They may come from a certain mine or group of mines. Each shipment is the closest mix possible to that of the guarantee. If the component parts are gathered in a train load and passed through the dock as such, or are stored at the docks in small separate blocks, the cargo will be homogenous. But if docked or loaded in large blocks of varying grades, the ore piles in the vessel will be segregated masses of distinct ores—maybe with one variety capping the cones—instead of differing layer by layer. This deposition of the ore, especially in the case of group ores or special grades, has a distinct influence on the sampling as will be shown later on.

At the Lower Lake Ports the unloading docks are variously equipped to remove the ore directly from the hold to cars or to stockpiles alongside. The principle of all is identical; to suspend an arm out over the boat, enabling a grab bucket to drop down through the hatch, pick up its load, raise it and swing back to discharge into railroad cars or the loading pit of the stockpile room. A boat is moored alongside the dock, with the machines mounted on tracks, able to range the length of the vessel, and be spotted, one to a hatch, in any order required. When ores are not loaded into railroad cars for direct shipment to the furnaces they are dumped into a pit on one side, from whence a large dam, suspended from a traveling bridge straddling the stockpile ground, picks them up and re-piles them for future shipment. The docks are owned and controlled by either the serving railroads or the consumers and are located at discharge points on Lower Lake Michigan, Pt. Edward, Detroit and Lake Erie harbors. Ports at Pt. Edward, Detroit and Lake Erie are usually known as the Lake Erie Forts; are 12 in number with as many as 7 and 8 docks at entries such as Cleveland and Buffalo.

The machines used vary from the 2-ton McMyler Whirlies, a revolving crane type, to the huge electric Huletts with their 17-ton buckets and representing a quarter million dollar investment per machine. Electrically controlled 5-ton grab buckets, hung and traveling on an overhanging bridge, are in wide use, but all varieties are gradually being replaced by the Hulett design. This is a rigid vertical arm, terminating in a great gathering bucket, and suspended from a tilting frame. The machine is moved out over the hatch, frame tilted down, thus plunging the arm into the hold. The operator riding just above the bucket controls the entire mechanism and swings the bucket to any angle or depth. Seventeen tons are handled per minute per rig under straight digging conditions with 4 machines able to unload and clean-up a 12.000-ton boat in average of 5 hours. Car supply, construction of boat, type of machine, skill of operators, condition of the ore and power used control the speed of unloading, which ranges from 24 hours with the 2-ton Whirlies to the record time of 3 hours, 5 minutes for 7 Huletts unloading 12,508 tons. Almost every type of rig first discharges into a weighing hopper, which is an integral part of the machine, where the weight is recorded before dumping. As all the cars used are of the large coal type, the ore is placed in a pile at either end of 25 tons each. Cars are spotted under the weighing hoppers by mechanical mules, or the rig is shifted over the cars.

From the sampler's standpoint the ideal proceedure of unloading is to have the rigs first start to dig into the heavy hatches and cut straight down to the bottom skin in every successive hatch. This then gives two high, almost vertical, ore faces in each hatch from which to sample and the exposed surfaces are true cross sections through the piles. The smaller peaks of ore between the hatches are then gathered up by swinging the buckets and cross-cutting. But due to inclinations of the machine operators, or certain local conditions, this is not always done. Theoretically it should be the fastest method as

the buckets get a full load quicker when cutting straight down, the boat is lightened and rises faster thus giving a decreasing height through which to lift the loads. Cross-cutting before reaching skin flattens the piles, making it necessary to sample from top surfaces instead of faces that slice down through the varying layers of the cones. In 12-foot centers the rigs sometimes begin in the light hatches, which in turn is some hinderance to the best sampling. After the bulk of the ore is removed laborers are set to scraping the unreachable small quantities of ore into piles accessible to the machines. The unloading progresses evenly over the entire length of the boat so that proper trim is maintained. This necessitates shifting the rigs continuously though with equal proper working each one can cut to skin before moving up.



UNLOADING ORE FROM BOATS AT LOWER LAKE PORTS

As the yearly demand grew, and consequent production of ores increased from the Lake Superior Region, stabilized methods of docking and sampling were evolved and perfected—especially since the tremendous growth and complicated operations of the consumers demanded exact calculation of furnace burdens long before their charging, with a resultant necessary basis for guarantees and price calculation. After 1907, when the present system was put into effect, standardized methods of sampling and analysis were adopted by all the Lower Lake Chemists, as it was agreed, between seller and buyer, chat the determination of grade and calculation of price should rest upon these chemists' findings. The faith invested in them has been justified.

To cover the many scattered delivery points, and to render prompt and efficient service to the handlers of the ore, it is imperative to maintain a full corps of trained samplers at every port with means of communication to a central point. The directing organisation and large laboratories are at this center, from whence the results are rapidly dispatched to seller and buyer. Thus the organization and equipment required by the chemists is large and widely spread, though extremely smooth and fast in its many connecting steps. All of the work is done by a small group of long established firms; each with their independent organizations but all working with the same standard methods. For example, the firm of Crowell & Murray, established in 1884, has been operating continuously for 40 years with its complete organization covering every unloading port. During a heavy year, such as 1923, it is not uncommon for one firm of chemists to sample and analyze a total of 15,000,000 tons of iron ore. It is the usual practice to have each cargo sampled and analyzed by two firms of chemists working independently, thus obtaining an indisputable verification of the analysis.

Correct sampling must always rest upon a mathematical system which eliminates the human equation and is, therefore, based on a mechanical formula. The many varieties of ore, methods of unloading and local conditions require that this formula cover every conceivable situation and be applied quickly without calling on the judgment of the sampler.

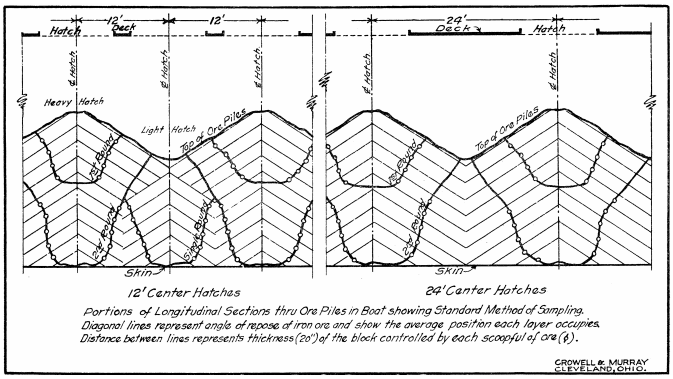


DIAGRAM SHOWING HOW ORE SAMPLES ARE TAKEN

The unloading rigs cutting down through the ore under each hatch lay bare more or less regular sized faces at equal distances apart. The ore may be lumpy or fine, well mixed or blocky. The sampling then must cover these exposed surfaces with mechanically spaced taking points, obtained at certain stages of the unloading, of sufficient number so that each one represents a small equal block of the total ore, and a mix of them all is a proportional representation of the entire cargo. By measuring short distances along definite lines running over the cut ore faces, and taking equal portions of whatever ore these points fall on—irrespective of whether it is lump or fine, looks good or bad—the sampler is relieved of all personal decision.

Three to four samplers are employed on each cargo with each sam-of one-half pound ore capacity, and a hammer. He descends into the hold and takes what is known as sample rounds under each hatch promptly after the machine has opened up the ore pile. The rigs, in digging, trench the piles across, thus leaving two almost vertical ore faces par hatch. The sampler starts the round at one side in the bottom of the trench, where a scoopful is taken, and then measures up the face vertically, taking a scoopful every two scoop lengths (about 20 inches). On reaching the top of the trench, the sampler then measures 4, 6 or 8 scoop lengths over (according to size of cargo) and repeats the two scoop length line of points up the face. In this manner the entire trench surface is traversed back to the starting point. A level scoopful is taken from wherever the measured point falls, and if a lump is encountered a chunk the size of a scoopful is broken off with the hammer. All ore portions are immediately placed in the can as taken.

The standard method provides that the sample rounds be taken at the following stages:

In 12-foot center boats take alternately two and one rounds, taking two rounds in hatches first cut by the rigs, and one round from the in-between hatches. In the two round hatches, the first round is taken when machine has cut half way to bottom, exposing faces 6 to ten feet high, and the second round when the bottom is reached where vertical faces are exposed from top to bottom.

In the next or one round hatch, the round is taken when the machine has cut to the bottom.

In 24-foot center boats take two rounds from every hatch; the first when halfway to skin and the second when the skin is reached.

When the rigs are turned and cross-cut before a trench is completed, flat surface result. Samples with the same equal spacing are then taken straight across under each hatch, in lines spaced as before with first line starting two scoop lengths away from either side of the boat.

A sieve test sample, when called for, is taken separately with the same equally spaced points on two vertical lines midway between the center and the side of the boat. These rounds are taken in alternate hatches on 12-foot center boats and every hatch on 24-foot centers when the hatch has been cut to bottom.

Diagram on opposite page will illustrate how a scoopful of ore is obtained from small equal sized blocks under each hatch and from points on the varying layers of the cones thus being indicative of the whole. The sample of a 10,000 ton cargo is taken from an average number of 2,400 separate points.

The real value of the shipment is determined by the sampling—all else are steps leading to or from it. Therefore the conditions of the exposed ore faces, as controlled by the loading and unloading, are influences on the sampling in spite of the above blanket method. As the scoopful is taken regardless of what is underneath the point, any mauling or premature cross cutting of the machines is liable to bring a portion of the pile into undue prominence. This is aggravated by blocky loading of the ore, as then any slides of the top covering down the almost vertical faces may carry this particular grade again into the bottom round and give excessive weight to this ore in the composite sample. Also, be-pler attending to a designated number of hatches. Each sampler carries an ore can of about 35 pounds capacity, a small standardized iron scoop cause of the impartial taking of points, this blocky loading with its tendency to the segregation of lumps may cause the sampler to take more or less of the lumps than if well mixed. By first starting digging in the heavy hatches, when two rounds are taken, a more representative sample can be obtained than if the rig started in the light or low hatch, since some ore is missed if a top round is taken from the in-between hatch. Again it is repeated, the better the loading and unloading the better the sample will be.

The cans of ore as taken by the samplers are collected at one point on the boat, protected from weather, and all lumps broken down to ½ inch ore less with careful handling so that no portion is lost or contaminated. As many as 35 cans, representing a weight of 1,200 pounds, are taken in a 10,000 tons cargo.

This total sample is very exactly coned and quartered down until a final composite sample of 35 pounds remains for analysis. Portions of the total sample at various stages in the quartering are set aside in an air tight can for a separate moisture sample. The final samples are then immediately sent to the central laboratory for determination. When a sieve test sample is taken it is coned and quartered down without any breaking down to small size.

On reaching the laboratory, the moisture sample without further handling is at once dried at 212° Fahrenheit to constant weight and the moisture content obtained. The standard sample is thoroughly dried and crushed and quartered down to a six ounce final sample passing 100 mesh sieve. One-half is reserved for a check determination and one-half is used for analysis.

The chemical constituents of the ore are determined by standard analyses methods and the results placed on cards and dispatched to seller and buyer. Calculation of the natural iron from dried iron and moisture content is performed by the chemist. One or any number of the constituents may be called for and in addition a sieve analysis is frequently required which is determined from the separate sieve sample, taken only when requested, and screened according to standard practice.

Any wide divergence in results between the two sampling firms having the cargo, or marked difference between mine and lower lake analysis, is settled by re-running the reserved check sample, or the sample is sent to an umpire or laboratory of the interested parties.

Suffice to say, this very seldom happens and, if so, is always quickly adjusted. It is remarkable how closely the mine and lower lake analysis check each other, and especially how the average of the Lower Lake Chemists results on a season's shipment of a guarantee coincide with that of the mine's.

As all ores are paid for on the basis of the natural iron, since the moisture content may vary more or less and thus affect the weight, from the time it leaves the mine until it reaches the furnace, it is extremely important that the sampling both at the mine and at the lower lake ports be regulated for this.

The boat sampler never takes any ore from the exposed top surfaces of the piles as these may have been rained upon or dried out. Otherwise he takes the samples as encountered. Therefore the mine sample from cars should be taken immediately after loading, either at the shaft pocket or in the pit. If this is done, the weather equation is eliminated and a closer check will be obtained between the two analyses for moisture.

A sampling and analyzing of ores at the Lower Lake Ports is now a standard and successful method, and the unloading largely so. When the same careful, mechanical sampling is done at the mines and the same supervised attention paid to it, there is always harmonious results. The continued cooperation of seller and buyer is thus needed to insure this consummation.

MINE TIMBER USED UNDERGROUND.

The Bureau of the Census under the Department of Commerce in Washington has prepared a questionnaire, Form No. 201, entitled "Mine Timber Used Underground," Calendar Year, 1923. It was made after conferring with associations and mining engineers. Copies will be sent out through the Geological Survey after January 1, 1924, which department, together with the Bureau of Mines, Department of the Interior, the Forest Service and the Department of Agriculture, have cooperated in this work. As stated in the questionnaire, the last census of this kind was carried out in 1905. The Bureau urges publicity through this Institute and requests prompt action in making returns. It promises to furnish data based on the results soon after the last information has been received. The need of cooperation of mining men in the conservation of the rapidly diminishing timber supply will be apparent to all operators.

For the information of the members copy of the questionnaire is published in the two pages following.

File No. .....

Form 201

DEPARTMENT OF COMMERCE

BUREAU OF THE CENSUS

IN COOPERATION WITH

DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
BUREAU OF MINES

DEPARTMENT OF AGRICULTURE
FOREST SERVICE

MINE TIMBER USED UNDERGROUND
CALENDAR YEAR 1923

TO MINE OWNERS AND OPERATORS:

Very little information exists as to the quantity and kinds of timber used in the mines of the United States. The only previous census of this kind was carried out in 1905. Since that time forest conditions have changed materially.

The cooperating bureaus invite the careful attention of mine operators to the following questions, in order that a report may be compiled which will be of service to them.

All replies are held confidential, and such publication as may be made will not reveal operations of reporting mines.

A separate report is needed for each mine in which timber is used. Additional blanks may be had by addressing the Director of the Census, Washington, D. C.

1. DESCRIPTION OF ESTABLISHMENT:

a. Name of mine.....

b. Location of mine: Post office, ...; county, ...; State, ...

c. Name of operating company.....

d. Address: Post office, ...; county, ...; State, ...

e. Kind of mineral or principal ore produced.....

f. Aggregate quantity of coal, crude ore, or other mineral mined, 1923, ... tons.

g. What is the production of an average normal year? ..... tons.

h. Estimated quantity of waste or rock excavated in mining, 1923, ... tons.

2. USE OF TREATED TIMBER AND SUBSTITUTES:

a. Does your mine use any treated timber? .....

b. If so, state approximate per cent of all timber used underground which is treated with preservatives ..... per cent.

c. Does your mine use steel or concrete or both as a substitute for timber? .....

d. If so, in what year did you begin the use of steel or concrete underground? .....

e. Quantity of timber substitutes used underground in 1923: Steel, ... tons; cement, ... barrels.

f. Considering your total yearly construction underground as 100 per cent, what part do you estimate is now done in concrete and steel instead of wood? ..... per cent.

INSTRUCTIONS FOR ANSWERING INQUIRY 3 ON REVERSE OF THIS SHEET.

QUESTION A. If other forms of timber are used, insert the names in Column 1. The quantities of sawed timber or lumber and the cost should be taken from records if possible; otherwise your best estimate is acceptable.

QUESTION B. If other forms of timber are used, insert the names in Column 1. Estimate the average diameters to the nearest inch. The linear (running) feet consumed should be from record if possible; otherwise the number of pieces multiplied by the average length will give a good approximation. Where large quantities of split timber are used, a corresponding reduction of the volume should be made by decreasing the linear feet reported to one-half, one-third, or one-fourth, according to the average splitting used. If the timber is recorded in board feet, cubic feet, or other unit change the column headings to show the unit of measure and report the quantity accordingly.

QUESTION C. Add names of other important species used. An estimate should be made, showing the per cent of total sawed timber and the per cent of total round and hewed timber contributed by each kind of wood. The sum of the per cents in the columns for sawed timber and the sum of the per cents in the columns for round and hewed timber should each be 100.

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3. QUANTITY AND KINDS OF TIMBER USED UNDERGROUND, 1923.

A. SAWED TIMBER. (See instructions, page 1.)

FORMS [1]	Quantity used (board feet).	Cost at mine (dollars).[2]	Principal State from which obtained.
Legs or posts			
Ties			
Crossbars (collars)			
Lagging			
Other (specify)			
TOTALS			

B. ROUND, HEWED, OR SPLIT TIMBER.—(See instructions, page 1.)

FORMS.[3]	Average diameter (inches).[3]	Total linear (running) feet consumed.[3]	Cost at mine (dollars).[2]	Principal State from which obtained.
Props				
Ties				
Crossbars (collars)				
Lagging				
Other (specify)				
TOTALS				

[1] Add others, if necessary.
[2] Include freight charges.
[3] If timber used is recorded in board feet or cubic feet specify unit of measure, state quantity, and omit average diameter.

C. KINDS OF WOOD USED.—(See instructions, page 1.)

KIND OF WOOD.	Per cent of total sawed timber.	Per cent of total round and hewed timber.	KIND OF WOOD.	Per cent of total sawed timber.	Per cent of total round and hewed timber.
SOFTWOODS:			HARDWOODS:		
Pine			Oak		
Douglas fir			Maple		
Hemlock			Beech		
Spruce			Birch		
Tamarack			Chestnut		
			Elm		
			Aspen		
			TOTALS	100.0	100.0

Date of this report: .....

.....
(Signature and official title of person furnishing the information.)

.....
(Address.)

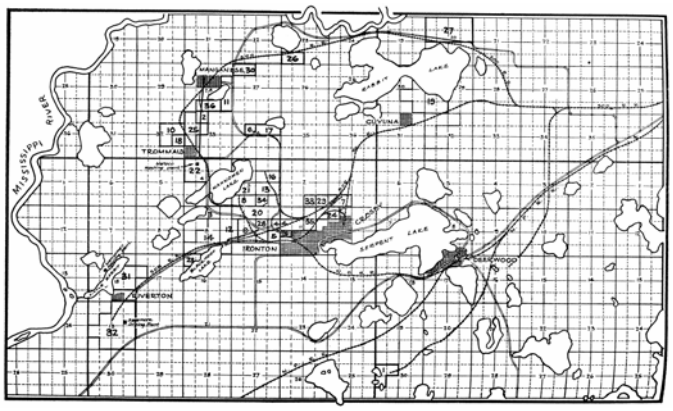
REMARKS: .....

.....

.....

.....

U. S. GOVERNMENT PRINTING OFFICE 11—8321



MAP OF A PORTION OF CUYUNA RANGE, COMPILED BY HOLMAN I. PEARL, CROSBY, MINNESOTA, AUGUST, 1923

LIST OF MINES ON THE CUYUNA RANGE.

(Compiled by H. I. Pearl, Crosby, Minn., August, 1923.)

	Mine.	Operator or Owner.	Iron or Mang.
° 1	Adams	Biwanago M'n'g. Co.	Fe.
° 2	Algoma	Iron Mountain M'n'g. Co.	Mn.
° 3	Arko	Shawmut Co. (Fee)	Mn.
4	Armour No. 1 & 2	Inland Steel Co.	Fe.
5	Bonnie Belle	Liberty M'n'g. Co.	Fe.
° 6	Clarke	Chappaquiddick Co. (Lessee)	Mn.
7	Crott	John A. Savage & Co.	Fe.
° 8	Cuyuna-Mille Lacs	Cuyuna Mille-Lacs Iron Co.	Mn.÷Fe.
° 9	Feigh	Northwestern Improv. Co. (N.P.R.R.)	Fe.
°10	Ferro	Gorham-Garbett Co. (Lessee)	Mn.
°11	Gloria	Gloria M'n'g. Co.	Mn.
12	Hillcrest*	Hillcrest M'n'g. Co.	Fe.
°13	Hopkins	John Hopkins (Fee)	Mn.
°14	Huntington	Whitmarsh M'n'g. Co.	Fe.
15	Ironton	Inland Steel Co.	Fe.
°16	Joan No. 1	Joan M'n'g. Co.	Mn.
°17	Joan No. 3	Joan M'n'g. Co.	Mn.
°18	Joan No. 4	Joan M'n'g. Co.	Mn.
19	Kennedy	Rogers-Brown Ore Co.	Fe.
20	Mannomen*	Clement K. Quinn Ore Co.	Mn.÷Fe.
°21	Mangan No. 1	Mangan Iron & Steel Co.	Mn.
22	Maroco*	Marquette Ore Co.	Fe.
°23	Martin	Whitmarsh M'n'g. Co.	Fe.
°24	Meacham	Rogers Brown Ore Co.	Fe.
°25	Merritt	Merritt Development Co.	Mn.
26	Milford	Whitmarsh M'n'g. Co.	Mn.
°27	Northland	Northern Minnesota Ore Co.	Mn.
28	Pennington*	Pennington M'n'g. Co.	Fe.
29	Portsmouth*	Gordon M'n'g. Co.	Fe.÷Mn.
°30	Preston	Cuyuna Central Iron Co.	Mn.÷Fe.
°31	Rowe*	Murphy and Williams (Fee)	Fe.
32	Sagamore*	John A. Savage & Co.	Mn.÷Fe.
33	State Pit*	Inland Steel Co.	Fe.÷Mn.
°34	Sultana	Campbell & Joyce (Fee)	Mn.
°35	Thompson*	Haley & Keating (Fee)	Fe.
°36	Zeno	Geo. H. Crosby (Fee)	Fe.

*=Open pit.
°=Inactive.

THE LAKE STATES FOREST EXPERIMENT STATION AND THE MINING INDUSTRY.

J. A. Mitchell,* St. Paul, Minnesota.

Within the last few months there has been established in the Lake States one of eight federal forest experiment stations located in important forest regions of the country. The Lake States Forest Experiment Station is intended to serve the interests of timberland owners and wood users in the states of Michigan, Wisconsin and Minnesota. Headquarters have been established in St. Paul, in cooperation with the University of Minnesota, and a trained staff assembled. The function of the forest experiment stations in the field of forestry may be likened to that of the agricultural experiment stations in the field of agriculture. Through them it is hoped to solve the various technical problems of management and administration confronting the timberland owner who desires to handle his forest properties to the best advantage.

Heretofore timber has been considered as a more or less inexhaustible natural resource to be exploited as coal and iron without thought of replacement. The result is that today two-thirds of our virgin forests are one and the balance are being cut four times as fast as they are being replaced by new growth. The last fifty years has seen the center of lumber production move from the East to the Lake States, from the Lake States to the South, and from the South to the Pacific Northwest, each move being marked by an increase in lumber prices due to the longer haul, mounting stumpage prices, and increasing labor costs. While there is yet no physical shortage of lumber generally, certain kinds and classes of material are no longer obtainable in quantity and the price of lumber for many purposes is becoming prohibitive. Within ten years eighty per cent of the large mills of the South will have finished, making the country dependent entirely upon the Pacific Coast operations in the matter of lumber prices. With the cutting of the virgin stands on the Pacific Coast the last of the virgin timber in the states will be gone and there are no more virgin stands within reasonable distance that can be had to supply our needs.

In the paper industry conditions are even more serious for with our own supplies of pulp wood running low and an embargo threatened on the further export of Canadian wood, the present source of one-fourth of the wood and wood pulp used in this country, it is becoming a question which way to turn, since the paper manufacturer unlike the lumbermen can not pack up and move from one region to another as the available timber is cut off. His investment in plant and equipment is too large and it is usually dependent on a waterpower development. This means one of two things, either that supplies of raw material, in this case pulp wood and wood pulp, must be shipped in from increasing distances at a cost that must eventually become prohibitive, or it must be produced locally.

*Silviculturist, Lake States Forest Experiment Station.

The mining industry is in much the same condition as the paper industry, except that their needs are not so large. Nevertheless the mine timber situation has already become locally acute and is beginning to receive serious consideration in a number of mining regions. England during the war can be cited as an extreme example of what the lack of a local supply of mine timber means, for it was the lack of such material that resulted in the closing down and curtailment of output of the coal mines and constituted a most serious emergency. In the Lake Superior mining district the situation apparently has not yet become acute, for located as it is in the heart of what has been one of the greatest lumber producing regions of the country it has had abundant material available. Each year, however, the more desirable species are becoming scarcer, the haul is longer, and the price of stumpage higher. Material is being accepted and used today that a few years ago would never have been considered. What can be done to meet this condition? One measure is the more extensive use of a preservative treatment; another is a more economical use of the available material, and a third is to grow the timber needed.

One of the chief obstacles to the practice of forestry in this country so far has been the lack of a market for small stuff. The needs of the paper and mining industries place them in a favorable position in this respect since pulp wood and mine props can be grown in comparatively few years. The mining companies also often have large tracts of land of little or no value for any other purpose which, all other considerations aside, it would be good business to make productive. A number of large mining concerns in the older mining districts of the East are already giving serious consideration to the reforestation of their holdings and several are spending large sums to this end. The New Jersey Zinc Company, for example, employs several foresters and has already put its lands in such shape that they are supplying all the mine material needed for its operation, and eventually will derive an income from the sale of surplus material over and above the cost of protection and management.

There are a number of things though that the mine owner, or anyone else for that matter who contemplates the practice of forestry, wants to know before embarking on the enterprise. What for example is the land best suited to, what yield can be expected, what methods will produce the greatest quantity of desired material in the shortest possible time, and last but not least what it will cost? At the present time both the paper and mining industries are using high grade timber when inferior trees would serve their purpose. On the other hand material is now going into saw logs or being left in the woods that might better be utilised as pulp wood or mine material. Mine props could be obtained from thinnings which instead of depleting the forest would actually improve its condition and increase the growth of the trees left standing. It is an entirely feasible proposition, so to manage forest lands that mine props and pulp wood are produced as a by-product in the production of saw timber.

Other questions of interest to the mining and paper industry are:

The extent of existing supplies of forest material, its location and accessibility, and the rate at which available supplies are being exhausted. These and other pertinent questions will receive the attention of the Lake States Forest Experiment Station as fast as men and funds are available. The answers to many of the questions will require the assistance and cooperation of the industries concerned. The station also will welcome the advice and suggestions of those interested. At the present time, the Department of Agriculture, of which the station is a part, is considering the appointment of an advisory committee representing the important industries of the Lake States region. Through it the station hopes to keep in touch with the problems and needs of the various industries concerned. It is the aim of those responsible to make it a real factor in the progress and upbuilding of the industries of the region and the development of the region itself.

REFORESTATION AND FIRE PROTECTION.*

By Wm. F. Cox, State Forester of Minnesota, St. Paul, Minn.

(The following paper is of much importance to the mining industry in view of the diminishing supply of suitable timber. Each year the difficulty of obtaining the necessary material at a reasonable price is increased, not only by the gradual cutting but also in many instances by wasteful methods of lumbering and the destruction caused by numerous forest fires.

Publicity of what is being done calls attention to the need of compliance with regulations. It is to be hoped that uniformly adopted regulations will be imposed in the forest districts to prevent further waste. To guard this diminishing supply a more or less rigid system should be built up which can only be brought about by cooperation with federal and state authorities. The United States Government has established the Lake States Forest Experiment Station at St. Paul with Dr. Raphael Zon as Director. Later it is planned also to establish Field Stations in Wisconsin and Michigan. The latter states together with Minnesota have enacted legislation for forest regulation.)

One-half of Minnesota is forest or woodland. This immense area is being reduced gradually through clearing operations incident to farm development; but a large proportion should, and probably will, remain forest land. Timber in the Lake States reproduces readily through natural seeding, and according to available data, seems to grow as rapidly as do the timber trees of New England, or of Germany or Scandinavia.

The great and populous states of Illinois, Iowa, Kansas, Nebraska and the Dakotas, as well as Michigan, Wisconsin and Minnesota, demand a local supply of timber which can be furnished only through protecting and developing the forests of the three last named states. To depend upon other sources of supply, even to the extent we are now doing, means tremendously long shipments with consequent high freight rates, a needless drain upon our resources to the extent of many millions of dollars. It means also the stifling of many industries now started in the Lake States, but which cannot long exist without a local and dependable supply of timber products. Such, for example, are the paper mills, box factories, woodenware concerns, and even the mines which must have an abundance of timber for props and lagging. The canning factories and packing houses cannot prosper where crates and packing boxes must be shipped in at high cost.

The arguments in favor of practicing forestry in the Lake States are not mere arguments—they are outstanding unanswerable facts, written in letters a mile high, that may be read across the continent.

*This paper was delivered at a recent meeting of the Engineers' Club of Northern Minnesota and is published by the courtesy of this society.

Experimental and practical work for a hundred years in Europe, for twenty years on the National Forests of the United States, and for ten years by this department has shown with definiteness how forests can be protected from fire at reasonable cost. Itasca Park and Forest is a good illustration of a considerable area given complete protection. Public welfare would seem to point therefore to early and adequate action to protect the lives of our settlers, and to perpetuate the productive forests which mean so much to our prosperity as an industrial as well as an agricultural region. Not only is it necessary to preserve our forests in productive condition, their beauty also must be safeguarded if we are to realize fully on the playground possibilities. Our big game, our fur bearing animals, and even some of our game fishes are largely dependent upon the protection of our forests,

Minnesota now has some of the best forest laws to be found in any of the States. The patrol system, in part provided for, the slash disposal law, the control of railroad fire danger, the bringing of the township chairmen into the ranger system and the burning permit law are all measures of major importance.

In view of the seriousness of the fire season just closed, it was exceedingly fortunate that the legislature gave the Forestry Board a considerably increased appropriation at the last session. This increased appropriation, together with assistance from the Board of Relief., the Federal Government and from volunteer settler organisations, enabled the rangers to successfully pull through a very dangerous fire period, but by a perilously narrow margin. The amount asked for by the Forestry Board last winter is as small an amount as prudence would dictate as a state contribution to fire protection and general forestry work.

Policy.

In addition to legislative appropriations, it would seem that the fire protection fund should be largely augmented through some fair measure of taxation of properties and interests directly concerned. Some lumber companies and timber owners are contributing voluntarily toward maintaining patrol and paying fire fighting costs on and near their properties. Others cannot be persuaded to do so. On account of the large number of different owners perhaps the fairest way would be to establish a "forest district" or "fire protection region" within which all land be required to pay two cents per acre or some such amount, for fire protection purposes to be expended by the Forestry Board. The fund might be raised by a fractional mill tax instead of on the acreage basis, but the acreage plan is used in Oregon and works very well. This would raise a fund of approximately $300,000.00 in addition to the state appropriation and would make possible the maintenance through the fire season of a more intensive patrol which in turn should bring about more intelligent and thorough going cooperation by local people in fire prevention and control.

Some years ago when I was at Washington we conducted a study of taxation of timber lands in Wisconsin. Since that time, similar studies have been conducted in other states. Invariably the conclusions reached have been that if timber crops are to be encouraged the land should be taxed separately from the timber, and the timber taxed only when cut. It is probably time to make an effort to obtain such legislation in Minnesota. New York, Louisiana and Pennsylvania have enacted some such legislation. If the Board so desires I shall be glad to prepare a bill.

Following the adoption of the Constitutional Amendment the legislature set aside 400.000 acres of state lands, as state forests. The term "New State Forests" applied to them is not sufficiently definite for administrative purposes. There are at least 600,000 acres of state timber land which have not yet been set aside as state forests, but which should by all means be established and handled as such in the public interest. Of particular importance are large tracts of pulpwood timber in Koochiching, Itasca, St. Louis and Lake Counties. To further permit destructive logging with the consequent ruin of these forest lands would seem to be little short of criminal when it has been shown by operations under the Forestry Board as well as on the National Forests that it is perfectly feasible to have them logged conservatively. Only by such action can we hope to have future crops of pulpwood and necessary timber.

The setting aside for forestry purposes of these timber producing properties already belonging to the state, thus providing for their management by the Forestry Board, entails no additional cost to the State.

There are some large areas of second growth timber and cut-over lands reproducing pine, spruce and other trees which should be purchased by the state and given intensive protection. These lands already stocked with growing trees can be bought for much less than the cost of planting bare land. The present owners, many of them non-residents, are giving these tracts of land no consideration whatever. It is probable that the state could issue long term bonds for the purchase of such property and the bonds be paid at maturity by the profits accruing from the timber growth. This may sound Utopian, but the best information available indicates that it might easily be done.

All state lands along lake shores and on islands should, in my judgment, constitute state forests and parks for timber production and playground purposes. All too many of our once beautiful lakes have had the forests destroyed on their shores and islands, leaving the lakes desolate and uninviting. Putting lake shores and island lands under the control of the Forestry Board would assure them better protection from fire and proper management for timber and scenic purposes. Lands bearing mature timber on lake shores, even though privately owned, should be maintained in their natural beauty where they are important as scenic attractions on the lake. Where the owners are willing to handle such properties in accordance with rules prescribed by the Forestry Board they should be permitted to do so. Otherwise, such lands should be acquired by the State.

Every resident of Minnesota is concerned in the welfare of our forests. Trees are a sort of common heritage affecting all of us while they live and equally so after they are made into lumber and other products. Members of the Forestry Board in whose hands lie the fate of our forest resources should be persons more than ordinarily concerned in the welfare of the State. Men, to make efficient rangers, must be expert woodsmen, able to run survey lines, estimate timber, scale logs, build trails, cabins and telephone lines, handle crews of fire fighters, supervise the disposal of slash and refuse caused by logging, deal with the public fairly, and enforce the forest laws.

The danger of pressure from commercial interests can be understood when we realize that the state has many millions of dollars worth of standing timber still to be sold and cut and that the proceeds of this timber goes to the school fund for our children. The difference in one year's cut of timber on State lands, whether logged properly or improperly, might easily amount to several million dollars in the next crop. A crop of trees requires a long time to mature. This is true whether the little trees are planted or whether they are allowed to come up naturally through proper logging and fire protection. Any policies dealing with the woods and their management cannot be changed every two or three years with political administrations if good results are desired. All of this is proved conclusively by the experience of federal government and of European countries. If we could have a legislative session during a fire season it is likely that more favorable consideration would be given the matter of forest fire protection. In a few months people seem to forget the danger, the financial losses and even the loss of life. Systematic protection through the ranger system is the only effective insurance we have against forest fires. The strengthening of this force is badly needed.

The fire plan now in use by the Minnesota State Forest Service is a combination of maps, plats, records and an assembly of data useful in the prevention, detection, control and suppression of forest fires. This plan has been in use for over six years, and improvements made on it each year.

The recorded data shows where the danger from fires starting is the greatest, and the cause for it. Some of the points taken into consideration in determining this are places frequented by campers, fishing streams, berry patches, wild rice fields, canoe routes, roads and trails traversing isolated forests and woodland tracts, new settlements where land clearing is being done and road grades through the drained peat beds of the State, and any place in the forest frequented by people. This data is used in determining the extent of the patrol force needed, the amount of educational work necessary such as posting fire warnings, cautioning individuals with the necessity of being careful with camp fires, burning matches, pipes, cigarette and cigar butts, etc., and assisting and advising new and inexperienced woodland settlers on burning the debris resulting from their land clearing.

The detection phase of the plan is a very important one and acquaints the ranger with the location of the fires soon after they start. This section of the plan consists of a series of lookout towers located at strategic points throughout the State, and a set of maps and plats used in the Rangers' offices and on the towers and in field books; also telephone systems connecting the towers and settlements with the ranger stations. The map shows the detailed geography of the country, the location of roads, telephone lines, ditches, villages, railroads, settlers' houses, etc. Over each tower location on the map is a transparent vernier or circle graduated to 360 degrees. When a smoke is sighted by the tower watchman or "lookout" as he is called, he places an instrument known as an alidade on the map which records a number of the circle which is in a direct line between the smoke and the tower. This reading is telephoned to the ranger station where the same information is received from one or more of the other lookouts. The distance between these towers is usually from ten to twenty miles. In the Ranger's Office is a map identical to the one on the towers including the transparent verniers. A string attached to a point on the map at exact location of each tower is used to triangulate the location of the fire. The strings are stretched across the map in such a position as to cross the vernier at the numbers corresponding to the readings received from the Lookout. The points where the strings intersect show the location of the fire.

During dangerous periods the rangers and patrolmen, who travel in various ways over the districts, either by auto, motorcycle, horseback, canoe and motor boat, are continually on the lookout for fires. Special arrangements for reporting of all fires to the rangers are made with from one to three settlers in each township. These men have telephone communication with the ranger station. The same arrangements are made with the eight hundred township fire wardens, appointed by the Forester, the State and County highway men, the rural mail carriers, the railway' mining and auto transportation company employes and any of the state or government employes who happen to be working in the timber area. This data is all compiled in the fire plan record and on the maps. In addition to this, the public is requested through newspapers, posters, circulars, bulletins, etc., to report all fires coming to their attention to the nearest forest office. Special note is made in the record book of the men among these cooperators who are capable of taking charge of fire fighting crews. The location of these men is also shown on the map and plats, with their telephone calls. Arrangements are made in advance with these men for handling this work so that they know exactly what to do when called upon.

When the report of fire reaches the ranger station the man on duty there looks on the map and in the record, and determines the extent of danger in the country where the fire is supposed to be burning, and the location of the nearest foreman to the fire, who is immediately called by telephone and requested to call out the necessary crew to extinguish it. As soon as possible after this has been done the ranger or a patrolman goes to the fire and gives additional instructions on handling it. Many cases on record show that within twenty-five minutes after a fire started men were at work upon it. Some of these fires were twenty-five or more miles from the ranger station. On an especially bad fire, or those burning in isolated areas, it is often necessary to take crews of men from the towns or villages. Contracts with the transportation companies for hauling men and supplies are made in advance and copies of these contracts are recorded in the fire plan record. Arrangements are also made before hand with the merchants of the different towns to furnish supplies. By this method, the ordering is simplified by having on file with the merchant a list of just what is needed for the different sized crews usually used. These lists are numbered 1, 2, 3 etc. No. 1 would contain the supplies necessary for a five-man outfit No. 2 for ten, etc.; so that all that is necessary for the ranger to do is to call a merchant by phone and tell him he wants list number so-and-so. Blankets, tents, and cooking outfits for different size crews are ready packed for instant use.

When a fire begins to reach dangerous proportions the ranger again turns to his map and first notices the location of all settlers' homes in the path of the fire, and arranges for special protection for them, and for the keeping clear of the main roads so that they may get out in case of necessity, and so that the fire fighters can get back and forth to the fire. Next, other property, such as hay, timber, etc., are taken into consideration.

Some of the other information shown on the Fire Plan Map and in the Record Book is the location of all tool and canoe caches. These are distributed over the district at various places where they will he handy when needed. The number of available men for fire fighting in each township village, lumber camp, sawmill or road camp and the supply of fire fighting tools available at each place, and transportation facilities such as autos, trucks, teams, boats, etc., are also shown. Each field man carries a copy of the fire plan map and keeps it up to date by adding any new roads, telephone lines, settlers' houses, or any other useful information. The road record shows the best transportation to any points in the district. This is of assistance in getting to fires quickly. The law prescribing a closed season on burning except by permit is one of the greatest measures for the safety of life and property in northern Minnesota. It has made possible the control of fires during several dangerous periods when otherwise the situation would have been hopeless.

The law provides for the appointment by the State Forester, of township fire wardens for their respective districts. The fire wardens are specifically authorized to issue burning permits. An effective feature of this law is in bringing the settler to realize when he obtains a permit to burn, that he is taking on a responsibility. To obtain a permit from a ranger, patrolmen or authorized township officer, is no great hardship and has a moral effect of the highest value. This has been thoroughly demonstrated. While an occasional settler resents statutory interference with his time-honored privilege of setting fire to his woodland, most residents of the timbered country have already learned the value of this legislation, and are heartily complying with its requirements. It is one of the best educational as well as police measures affecting the wooded districts. A person who gets a permit to burn is not relieved of responsibility for damage his fire may do; this is plainly stated in the permit. The issuance of these permits gives a tremendously increased effectiveness to the officers looking after fire prevention, since better track can be kept of fires and all authorized burning can be stopped during particularly dangerous times.

There is no worse fire menace than over-drained peat lands. Swamps which are promptly cultivated as soon as drained are no menace because they are protected. Swamps which are drained years ahead of any possible use for them are not only a complete waste of money— for the ditches fill up and brush runs riot—but also a crime against the neighboring settlers, for they become a fire trap. An experiment was tried in the dry peat lands. Twenty burning cigarette stumps were thrown on a dry peat ditch grade and watched. Nineteen of them started fires.

The building of a ditch in any peat section should not be permitted unless (1) there is very definite prospect of immediate use of the drained lands, (2) unless a gate or dam is provided to control the water and prevent over-drainage.

DULUTH AND THE MINNESOTA IRON RANGES.

(Data and Views Showing the Scope of Operations Pertaining to the Mining, Transportation and Smelting of Iron Ore in Minnesota.)

Compiled and Arranged by B. E. La Londe, Mining Engineer, Duluth, Minnesota, 1923.*

HISTORY OF DULUTH.

The history of Duluth commences with Daniel de Gresolon, Sieur Duluth, one of the explorers of the upper Mississippi, who came to the head of the lakes in the summer of 1679. Radisson and Groseillier, and Claude Allouez, a Jesuit priest, preceded Dulhut to the Lake Superior district, and are supposed to have visited the head of the lakes, but there is no authentic account previous to that of Dulhut. In 1792 the fur traders established a fort at Fond du Lac, on the St. Louis river, 15 miles above the present city of Duluth. I n the early 50's there were a few scattered squatters at Oneota and around the George Stuntz trading post on Minnesota Point. In 1855-56 the settlement on Minnesota Point was called Duluth, commemorating the name of Dulhut. The first railroad was built to the head of the lakes in 1870. The charter for this road had been granted in 1861 to the Lake Superior and Mississippi Railroad Company, afterward called the St. Paul and Duluth, and which is now a part of the Northern Pacific. In 1870 the population of Duluth was about 1,200. At present (August, 1923) it is given as 106,000.

*Oliver Iron Mining Co.

THE MINNESOTA STEEL COMPANY PLANT.

Site, 1,600 acres; waterfront, 2 miles; two blast furnaces—500 tons daily capacity each, thin lined, water cooled shells, 10 stoves, gas washers, etc.; 90 Koppers type by-product coke ovens; 10 open hearth furnaces—rated capacity 100 tons each, each furnace equipped with 437 h.p. boiler for utilizing waste heat; five 4-hole soaking pits; one 40-in. reversing Blooming mill, steam driven; one 28-in. finishing mill, motor

driven; one 16-in. continuous roughing train with 3-stand 12-in. finishing, 2-stand 10-in. finishing and 2-stand 8-in. finishing; power house—18,500 k.w. capacity; blowing engines, 5 gas driven, 40,000 cu. ft. capacity; pumping station—65,000,000 daily capacity; machine, forge and structural shops; three continuous reheating furnaces—regenerating type, designed to use 16 ft. billets, estimated daily capacity of L500 tons ingots; one rod and wire mill; all buildings steel frames, enclosed with 2-piece concrete blocks.

Manufactures—Angles, bars, merchant, billets, slabs, blooms, shapes for agricultural implements, concrete reinforcing bars, tar, sheet bars, coke, pig iron, wire rods, wire bright and galvanized, barbed wire, wire nails, woven wire fence.

Additional Data—B. F. stock house, 530 ft. long, built for estimated daily capacity 1,500 tons; power plant; 528x110 ft.; open hearth stock house, 333x80 ft.; merchant mill, 1,040x112 ft.; rail, structural and bar, etc., 1,060x120 ft.; long string of buildings, 1,970x300 ft.; machine shop, 280x140, 56,000 sq. ft. floor space; plate shop, 140x75 ft.; wire mill, 1,272x320 ft.

ZENITH FURNACE COMPANY.

In 1903 an organization was perfected at Duluth, having for its primary motive the manufacture of Bessemer and Foundry pig iron, for the purpose of supplying the trade tributary to the Head of the Lakes. The most serious obstacle confronting the enterprise at its inception was the inability to obtain high grade coke at prices which were not prohibitive. This problem was eventually satisfactorily solved by the installation of a battery of 50 by-product coke ovens. The by-products are gas (which is supplied to the cities of Duluth and Superior for illuminating, cooking and heating purposes), tar and ammonia. The annual capacity of the Zenith Furnace Company now aggregates about 500,000 tons of coal, 150,000 tons of coke, 110,000 tons of pig iron, 1,200,000,000 cubic feet of gas, 850,000 pounds of ammonia and 2,000,000 gallons of tar.

THE IRON RANGES OF MINNESOTA.

The first iron ore discoveries were made in Cook County in 1850 the first mine in St. Louis County being opened in 1884, since which latter year enough ore has been taken out to make steel rails sufficient to double track the railroad mileage of the entire world. The industry pays annually more than $31,000,000 in wages and $26,930,000 in taxes with transportation expenditures running into additional high figures. With the opening of the St. Lawrence Waterway it is expected that the ore production and movement will be materially increased, which will of course add still further to the prosperity of Minnesota.

Vermilion Range—The Vermilion Range extends from the vicinity of Tower to and beyond the international boundary, crossing into Canada at the eastern end of Hunters Island, Merchantable bodies of ore have been discovered at but three localities along this extent, one at Tower; one near McComber and the other near Ely. In the early 80's, Mr. Geo. C. Stone succeeded in interesting Mr. Charlemagne Tower in the ore deposits on the Vermilion range near Tower. The first shipment was made in 1884. In 1886 the whole property including mines, railroad, docks and land grant was sold to the Minnesota Iron Company and later, on the organization of the U. S. Steel Corporation, became a part of the holdings of that corporation. The first mine to be developed near Ely, 21 miles east of Tower, was the Chandler, which began shipping in the fall of 1888. Since then the Pioneer, Zenith, Sibley and Savoy have been opened in what is known as the Ely trough. Up to January 1, 1923 ten mines shipped a total of 46,267,725 tons.

Missabe Range—On the Missabe Range, ore was discovered in the fall of 1890 near Mountain Iron mine by the Messrs. Merritt of Duluth, and in the fall of the following year on the Biwabik property by the same parties. Since these discoveries the development of this range has been phenomenal. This range extends continuously from near Grand Rapids on the Mississippi river E. N. E. for a distance of about 90 miles to near Birch Lake, where it is covered by the large gabbro flow which forms the base of the Keweenawan Series. On this range 222 mines have produced from beginning of operations to January 1, 1923 a total of 602,241,998 tons.

The Cuyuna Range—The Cuyuna Range was located from the results of magnetic work done by Mr. Cuyler Adams about the year 1895. Very little was done, other than magnetic research work, until the year 1904 when the first drilling was started in Section 16, T. 46, R. 28 about a mile southeast of Deerwood. The first shipment of ore from the Cuyuna Range was made in 1911 from the Kennedy mine. Thirty-six mines shipped, from that time to January 1, 1923, 15,837,852 tons.

IRON ORE CONCENTRATION ON THE WESTERN MESABI RANGE.

The concentration of the so-called "wash ores" of the Western Mesabi was worked out by the Oliver Iron Mining Company at an experimental plant at Coleraine, resulting in the building of a large mill in 1909. This was followed by other plants of similar design. There are now some 15 of such plants in operation west of Hibbing. The total production of these plants for the year 1920 was 6,500,000 tons of concentrates. The average iron content of these concentrates is probably not less than 53.50 per cent iron natural. A large portion of the ore on the Western Mesabi Range occurs mixed with sand, making it necessary to build washing plants to remove the worthless material and bring the ore to a merchantable grade. The wash ore area on the Mesabi Iron Range covers a region of the iron bearing formation extending from Grand Rapids on the west to the Hibbing district, about 40 miles eastward. The increase in the number of washing plants completed each year on the western Mesabi shows that the products must be of a structure desirable for furnace operation. The washing of iron ores in Minnesota has resulted in the recovery of a large tonnage which would otherwise have been unmerchantable owing to its excess silica content.

Some Iron Ore Washing Plants on Mesabi Range.

Plant—	No. of Units	Plant—	No. of Units
Trout Lake	6	Harrison	1
Danube	1	Mace No. 2	½
Hill Annex	2 (a)	York	½
Majorca	½	Shada	½
Draper	½	La Rue	½
Patrick	1	Crosby	½
Hawkins, Minn.	1	Webb	½

BABBITT MINNESOTA.

Twelve miles east of Mesaba the Mesabi Iron Company has commenced the building of the new town of Babbitt. The plant itself is located about a mile distant on an ideal mill site the ground falling away to the northward one mile and a half to Birch Lake. The Mesabi Iron Company controls most of the magnetic taconite of this region between Mesaba and Birch Lake, comprising an area of probably between 12 and 15 square miles, together with much non-mineral land for dumps, trackage and other industrial purposes. In 1915 the Mesabi Syndicate was organised with the idea of investigating the

possibilities of the Eastern Mesabi Range and within a short time thereafter engineers were in the field and an experimental mill, having a capacity of 100 tons; per day, was constructed in Duluth. This experimental work was continued until the spring of 1919, at which time the total expense in connection with this work alone amounted to something over three quarters of a million dollars. The Mesabi Iron Company was incorporated in 1919 with a capital of $3,000,000 for the purpose of developing and working low grade iron ore deposits on the eastern portion of the Mesaba Range.

FLOW SHEET OF MESABI IRON COMPANY'S CONCENTRATING PLANT AT BABBITT, MINNESOTA.

Quarry (Crude ore:) met. iron 27% silica 50%—Phos. .07
↓
Cars—Capacity 24 tons each
↓
Pocket—8,000 tons
↓
Apron Conveyor—8′ wide
↓
48″ x 72″ Jaw Crusher—Capacity 450 tons per hour Product 12″
↓
36″ x 54″ Jaw Crusher — 450 tons per hour Product 6″
↓
4—20″ Gyratories — 100 tons per hour each.— Product 1.5″
↓
42″ Conveyor — 400 tons per hour 55% full
↓
Equalizing Storage Pile —25,000 tons
↓
2—30″ Conveyors
↓
Magnetic part to cobbers to rolls and back to screens — (Screens 2″) (" 1.25″) (" .25″) (" 6 Mesh) — Non-magnetic Tails to Rock Bin
↓
Final Product—6 Mesh (Met. Iron 38%)
(Amounting to 2/3 of original weight of which 50% is—150 Mesh)
↓
Stockpile—Capacity 70,000 tons
↓
18″ Conveyor
↓
Demagnetizer
↓
6′ x 21′-8″ Dorr Classifier (-6+48)
↓
4′6″ x 14′8″ Rake Type Duplex Wet Cobber (Product: Tails & Concentrates)
↓
Demagnetizer
↓
2—8′ x 22″ Hardinge Ball Mills
↓
4—8′ x 21′8″ Duplex Dorr Classifiers
↓
Centrifugal Pump
↓
Demagnetizer
↓
6′ x 36′—18′ diam. Bowl Type Dorr Classifier (-48+100)
↓
1-Duplex Wet Cobber (Product: Tails and Concentrates)
↓
Demagnetizer
↓
1—8′ x 22″ Hardinge Ball Mill
↓
2—8′ x 32′—9′ diam. Bowl Type Dorr Classifiers
↓
Separator Feed (-100)
↓
5 Davis Magnetic Rake Washers (Products: Tails and Concentrates.) Perfect separation showing 99.8% recovery.
↓
5 Davis Magnetic Spiral Washers
↓
2—5′ x 20′ Dorr Thickeners
↓
Collecting Box
↓
2—6′ x 10′ Oliver Filters (1 is spare) — Product: Filter Cake and Filtrate. Cakes contain 10.5% moisture.
↓
Filter Cake
↓
Cake Cutter
↓
18′ Conveyor
↓
Hopper
↓
Feeder
↓
(Cake Cutter)
↓
Sinter Machine (Dwight Lloyd) (300 tons per 24 hours)
↓
Sinter Cake (Met. iron 64%—Silica 9% Phos. .027.)
↓
Toothed Rolls (Crushed to 4″ sizes)
↓
Cooling Tower
↓
Cars

RAILROADS.

The Duluth & Iron Range, The Duluth. Missabe & Northern and The Great Northern Railway Line (Missabe Division) all transport ore from the Missabe Range. The Duluth & Iron Range handles the ore from the Vermilion District. The following shows the general equipment of the ore carrying roads necessary for the handling of the enormous yearly tonnage from the Missabe and Vermilion Ranges.

Road—	Mileage	No. of Engines	No. of Ore Cars
Duluth & Iron Range	552 86	109	5,718
Duluth, Missabe & Northern	762 29	119	8,119
Great Northern (Missabe Division)	487.08	159	9,250

ORE DOCKS.

Duluth & Iron Range Ore Docks at Two Harbors.

Dock No.	No. of Pockets	Length Ft.	Width Ft.—In.	Storage Cap. Gross Tons
1	224	1,376	51′-8″	56,000
2	228	1,400	56′-8″	68,400
5	168	1,050	49′-0″	25,200
6	148	920	51′-¾″	37,000
	768			186,600

Duluth, Missabe & Northern Ore Docks at Duluth.

4	384	2,304	57′-0″	76,800
5	384	2,304	56′-0″	115,200
6	384	2,304	60′-0″	153,600
	1,152			345,600

Great Northern Railway Docks at Superior, Wis.

1	374	2,244	62′-8″	112,200
2	350	2,100	56′-0″	122,500
3	326	1,956	59′-8″	97,800
4	302	1,812	62′-6″	90,600
	1352			423,100

Northern Pacific Railway Docks at Superior, Wis.

1	102	684	57′-2″	35,700
Ex. of 1	100	600	59′-2″	35,000
	202			70,700

Minneapolis, St. Paul & Sault Ste. Marie, Ry., at Superior, Wis.

1	402	2,404	58′-0″	120,600

LAKE TRANSPORTATION.

One of the first ships of commerce to arrive in the harbor of Duluth was the Meteor, in September 1868. The capacity of this boat was about 500 tons. The first cargo of ore shipped from Minnesota was carreid by the steamer Hecla. The ore was loaded on August 19, 1884, at Two Harbors at the D. & I. R. dock and consisted of 1,427 tons. The Great Lakes ore fleet in 1922 includes 364 vessels having an average capacity of 8,-263 tons, or a total capacity of 3,007,400 tons per trip. The largest vessel (1922), length over all 625 ft., beam 59 ft., molded depth 32 ft. Hatches: generally 34 to 36 in number, size 9' x 34' to 9' x 88' opening. Spaced 12' centers. Capacity: 10,000 to 13,830 gross tons, restricted by channel depths; maximum draft is 20½ to 21½ ft. Cargoes of 14,000 short tons of coal are common. The Pittsburgh Steamship Company is the largest operating on the Great Lakes. It includes 78 steamers and 21 barges, the 99 boats having a total trip capacity of 808,400, tons. The Charles M. Schwab of the Interlake Steamship Company, with a carrying capacity of 12.000 tons of ore is one of eight steamers of similar size and capacity added to the ore fleet this year.

VESSEL LOADING RECORDS.

On September 6, 1921 the steamer D. G. Kerr loaded 12,507 gross tons of iron ore at the D. & I. R. docks, Two Harbors, Minn., in 16½ minutes. Only 19 minutes were spent at the dock from the time the boat went alongside until it backed away. On July 17, 1918, the steamer D. G. Kerr loaded 12,816 gross tons of iron ore at the D, M. & N. docks, Duluth, in 1 hour and 30 minutes, total time in port 3 hours and 5 minutes. (Distance navigated in harbor, 8½ miles along tortuous passage, including the passing and repassing of two draw bridges and tying up to dock.)

ITEMS OF INTEREST.

Shipments from Minnesota Mines—Average for 10 years, 1913-1922, inclusive, 35,157,116 tons; largest single year's shipment (1916), 46,189,-020 tons; length of train required to haul 1916 shipment, 4,203 miles. The Mesabi Range produced 55% of the total iron ore mined in the U. S. for a 10-year period ending in 1920. At the present time the Lake Superior District produces approximately 85% of the total iron ore mined in the United States. The Lake Superior District produced 72% of all iron ore mined in the U. S. from the beginning of the industry in this country.

Steam Shovel Operations—Total material moved by steam shovel to January 1, 1922, from Missabe Range mines: Stripping, surface rock, etc., 340,522,000 cu. yds.; lean ore, 13,453,000 cu. yds.; open pit ore (approximately), 172,256,000 cu. yds.; total, 526,231,000 cu. yds. Total material moved from Panama Canal to June 30, 1916, 282,355,339 cu. yds. (This includes wet and dry excavation from canal prism proper and locks, buildings, etc.) At one mine in the vicinity of Hibbing, Minn., a depth of 156 ft. in surface was stripped in one place on the property. The deepest open pit operation on the Missabe Range reached a depth of 334 ft.

Record Mine Shipments—The Hull-Rust mine shipped 7,665 611 tons in 1916 and a total of 19,579,779 tons for the three years 1916, 191'7 and 1918. This was all open pit ore.

Comparisons—The first steam shovel was brought into the Eveleth District in December, 1894, and weighed 35 tons—today some weigh 350 tons. Narrow gauge locomotives weighed 11 tons, and the stripping cars were 2 yd. capacity, today the cars hold 30 yds., hauled on 80-100 pound rails by locomotives weighing over 75 tons. This shows the improvement made in the mechanical equipment for moving dirt in the past 25 years.

The following table gives the distance in miles of Range towns from Duluth:

Town	Range	Railroad	Distance
Ely	Vermilion	D. & I. R.	116
Tower	"	"	98
Allen Junction	Junction Point	"	73
Two Harbors	Ore Docks	"	27
Biwabik	Missabe	"	87
Biwabik	"	D. M. & N.	78
Virginia	"	D. & I. R.	97
Virginia	"	D. M. & N.	72
Eveleth	"	D. & I. R.	100
Eveleth	"	D. M. & N.	69
Mountain Iron	"	"	72
Chisholm	"	"	81
Hibbing	"	"	84
Marble	"	"	77
Taconite	"	"	82
Coleraine	"	"	86

LIST OF MINES ON THE MINNESOTA RANGES WITH NAME OF OPERATING COMPANY AND TOTAL SHIPMENT TO 1923.
(Subject to Revision)

Oliver Iron Mining Co.—

Adams	23,072,878
Arcturus	1,916,943
*Auburn	2,143,028
Burt-Pool-Day	17,611,694
*Canton	713,048
Carson Lake	5,025
Canisteo	18,053,415
Chisholm	7,721,241
Clark	6,893,985
*Crescent	1,022
*Culver	120
*Diamond	171
*Duluth	1,794,472
Duncan	46,419
Fayal	31,563,070
*Gilbert	1,643,223
*Genoa	8,801,489
Glenn	5,285,596
*Hartley	390,108
Hartley-Burt-Palmer	3,797,381
*Higgins	1,425,466
Holman	8,878,221
Hull-Rust	67,037,220
*Humphrey	33,708
*Judd	634,137
Leonard-Burt	981,646
Leonard	11,862,614
Leonidas	6,101,708
*Lone Jack	2,210,398
*McEwen	583,399
*McKinley	109,086
*Minnewas	174,724
Messaba Mt.	12,713,255
Munroe-Tennor	2,258,743
Morris	16,549,046
*Mountain Iron	17,198,871
†Myers	1,610,105
*Ohio	1,884,490
*Penobscot	739,310
Philbin	2,307,659
*Pillsbury	1,640,265
Pioneer	12,903,021
Prindle	47,487
Roberts	2,951
*St. Clair	94,688
Sauntry-Alpena	9,383,924
Sellers	9,505,978
*Sharon	329,035
*Shaw	1,841
Sibley	3,298,688
Soudan	9,650,490
†Sparta	1,244,197
*Stephens	454,819
Sweeney	1,282,224
*Walker	3,086,939
Wanles	1,181,948
Wellington	125,330

P.ckands-Mather & Co.—

Albany	5,361,258
†Alexander	233,351
Belgrade	1,945,285
Bennett	4,643,722
Corsica	3,827,613
Danube	776,642
Elba	3,356,000
†Hudson	1,299,587
Mahoning	32,667,012
Majorka	858,798
†Minorca	1,265,120
†Malta	1,289,990
Mohawk	2,366,978
*Scranton	521,841
*Troy	671,260
Utica	4,665,451
*Virginia	1,019,237
†Yawkey	217,006
Zenith	6,321,004
*Prince Edwards	57,949

Republic Iron & Steel Co.—

Bray	751,623
†Franklin	2,241,761
Kinney	4,870,039
†Monica	469,723
†Onondaga	223,337
*Pettit	2,307,669
†Victoria	643,639
*Union	2,462,578
†Wills	64,522

M. A. Hanna Co.—

Alexandria	885,874
*Brunt	1,539,822
†Croxton	1,355,187
*Dale	3,310,956
Fay	1,003,945
*Frantz	657,667
*Hanna	1,536,633
Hobart	678,019
La Rue	3,310,974
Leonard	11,862,614
*Mesaba Chief	2,023
†Pilot	243,391
Thorne	541,244
†Sliver	2,497,239
North Uno G. N.	1,454,633
North Uno N. P.	1,038,928
South Uno	1,266,995

Joseph Sellwood Group—

†Adriatic	1,167,730
†Cyprus	1,783,900
†Pearson	505,295
†Perkins	612,893

*—Mines inactive. †—Mines exhausted.
(Tonnages and Divisions Subject to Correction.)

Shenango Furnace Co.—

Shenango	10,028,017
Webb	1,913,102
*Whiteside	759,181

Jones & Laughlin Co.—

*Columbia	16,987
*Fowler	926,195
*Grant	3,036,171
Hill-Annex	2,772,863
Leetonia	7,647,298
Lincoln	4,976,677
*Longyear	133,190
*Nausau	71,563
Mississippi	1,896,579
South Agnew	24,34[illegible]

Pitt Iron Mining Co.—

*La Belle	714,209
Miller	4,971,617
*Ruddy	203,302
Wacotah	1,190,342

Coates & Tweed—

Hill Crest	762,348
Julia (Formerly Bessemer Mine)	1,443,940
York	628,801
Portsmouth	350,186

McKinney Steel Co.—

Commodore	6,574,650
Schley	758,677
*St. James	1,557,856
*St. Paul	181,852
Stephenson	14,122,037

International Harvester Co.—

*Agnew	1,944,102
Hawkins	7,181,511

Oglebay, Norton & Co.—

†Woodbridge	1,651,907

Rogers-Brown Iron Co.—

Susquehanna	7,343,906
†Iroquois	1,358,412

Inland Steel Co.—

Armour No. 1	692,031
Armour No. 2	2,723,893
Ironton	361,151
Laura	2,956,652
State Pit	345,074
†Grace Mine	608,491

New York State Steel Co.—

†Knox	354,166

*—Mines inactive. †—Mines exhausted.
(Tonnages and Divisions Subject to Correction.)

Todd-Stambaugh Co.—

Biwabik	13,651,735
Dean	4,149,527
Billings	242,959
Cincinnati	219,006
Dunwoody	3,494,930
Itasca	1,036,791
*Orewell	None
Pennington	1,101,964
Morton	205,288
*North Eddy	468,846
*South Eddy	28,671
Warren	793,444

Cleveland-Cliffs Iron Co.—

Meadow	448,448
Boeing	250,474
Helmer	1,259,197
Hill-Trumbull	7,360,952
*Wade	480,305
Crosby	2,039,093

Meriden Iron Co.—

†Pearce	462,532

Cavour Mining Co.—

†Cavour	323,939

Butler Brothers—

Harrison	796,133
Kevin	525,314
Lamberton	168,488
*Margaret	178,862
North Harrison	2,690,903
Patrick	1,486,175
Quinn	886,011
Smith	514,527

Ajax Mining Co.—

*Ajax	207,650

Bowe-Burke Mining Co.—

Burns	261,909
Moresca	179,795
*Morrow	329,505

Brainerd-Cuyuna Mining Co.—

*Brainerd-Cuyuna	3,199

Brainerd Mining Co.—

*Barrows	56,439

Chandler Mining Co.—

Chandler	10,872,458

Fault Mining Co.—

Fault Mine	280,423
*Cyphon	81,422

Gloria Mining Co.—

*Gloria	2,038

Iron Mountain Mining Co.—

*Iron Mountain	106,060

Kingston Mining Co.—

Bradford Mine	282,071

Liberty Mining Co.—

Bonney-Bell	129,935

Mace Iron Mining Co.—

†Mace No. 1	1,107,768
Mace No. 2	1,033,992

Mangan Iron & Steel Co.—

*Mangan No. 1	134,743

Rogers Brown Ore Co.—

Kennedy Mine	2,202,118
Meacham	737,232

John A. Savage & Co.—

Draper	33,702
Croft	685,871
Sagamore	447,753

Section 30 Mining Co.—

*Section 30	1,431,308

The Thomas Furnace Co.—

†Cass Mine	241,243
†Williams	253,877

White Marsh Mining Co.—

Huntington Mine	40,591
*Martin	1,421
Melford	26,909

Rutland Mining Co.—

Aad Mine	161,865

Marquette Ore Co.—

Maroco Mine	152,068

Merrit Development Co.—

*Merrit Mine	142,728

Mesabi Iron Co.—

East Mesabi Mine	10,676

Mississippi Land Co.—

†Forest Mine	248,540

National Mines Corporation—

*McCumber Mine	8,386

Cuyuna Realty Co.—

Feigh	100,155

Northern Pacific Ry. Co.—

†Graham	1,155,084
*Vivian	73,542

B. W. Pattison Lessee—

*South Chandler Mine	2,236,776

C. K. Quinn Co.—

Madrid	216,919
Mahnomen	1,260,165
Shada	505,295
Wisstar	133,195

Miscellaneous Inactive Properties—

Arko	3,119
Chester	1,348,167
Ferro	151,783
Holland	322,558
Hopkins	43,106
Joann No. 4	40,328
Omaha	279,303
Rowe	895,443
Sullivan	20,048
Sultana	202,268
Thompson	1,020,005
Tioga	366,279
Wills	64,522

Miscellaneous Exhausted Properties—

Allen	74,947
Elizabeth	88,839
Emitt	300,712
Grace	608,491
Hector	521,353
Jennings	213,317
Jordon	945,644
Mayas	233,946
Midget	113,003
Normond	6,481,788
Ordean	965,914
Palmer	908,390
Savoy	1,862,229
Weed	320,575
White Iron	252,427

*—Mines inactive. †—Mines exhausted.
(Tonnages and Divisions Subject to Correction.)

BIOGRAPHICAL.

D. H. BACON.

The Institute has suffered another very sad loss in the death of Don H. Bacon, which occurred at his home in St. Augustine, Florida, November 17, 1922. He was one of the pioneers in the mining industry of the Michigan and Minnesota fields, progressive and fearless, and had a great gift for organization. He was outspoken in his views, was a dynamo of energy, and politically was an active republican.

Don Bacon came from New York state with his father in the early seventies, and the family located on a farm close to the city of Marquette. Shortly after that time a young boy, astride a white horse, rode up in front of the American Express office in Marquette and asked for the manager, Mr. W. Dalliba, explaining that he had come in response to an advertisement in the morning newspaper that a boy was wanted. Mr. Dalliba, looking him over, asked: "When can you start?" To which the boy answered: "Now." He put his horse in a near-by shed, pulled off his coat and started. That was characteristic of the man who was always prompt in decisions. The year 1872 found this boy assistant to F. P. Mills, Sr., ordering supplies for the Cleveland and McComber mines, Mr. Mills being the superintendent of these properties. In 1873 he was made superintendent of the McComber mine, which was located in the city of Negaunee, and he was also assistant to Mr. Mills. August 16, 1879, F. P. Mills, Sr., resigned as superintendent of the Cleveland company and Don Bacon was appointed to fill his position. In February, 1885, Mr. Bacon was made agent of the company in place of J. C. Morse, which position he held until his resignation in 1886, when he went to Minnesota with the Minnesota Iron Company, his place at the Cleveland being filled by the appointment, in 1887, of Frank P. Mills, Jr. Mr. Bacon made a pronounced success in his management of the Minnesota properties where he

spent several years when he resigned, moving east where he resided in New York for a time and finally established a permanent home in St. Augustine, Fla., where he died November 17, 1922. After his retirement from active business he spent some time traveling abroad, and frequently returned to the scenes of his earlier mining experiences in Marquette county where he greatly enjoyed meeting men he had known, and discussing the old days. He was a most companionable, man and one of unusual ability.

Albert B. Coates.

Albert B. Coates was born in Cleveland, Ohio, August 20, 1860 and was educated in that city. On account of ill health he moved to Virginia, Minnesota, in 1897, and occupied the position of bookkeeper and supply clerk at the Franklin mine, which position he held for several years. He served for a number of years as clerk of School District No. 22, comprising Virginia and Eveleth, being elected in August, 1900.

About 1901, Mr. Coates carried on logging operations in the vicinity of Virginia, Minnesota, and in 1905, in company with Morton Miller, opened the Mayas mine on the eastern end of the Mesabi Range. During his connection with the Mayas mine Mr. Coates became associated with Mr. George P. Tweed, later forming the firm of Coates & Tweed. The Mayas mine being extremely profitable, Mr. Coates secured other properties, such as the Alberta and Madrid, near Virginia, Madera and others. At the time of Mr. Coates' death the firm of Coates & Tweed controlled the York, Julia and Seville mines on the Mesabi and the Hillcrest and Portsmouth on the Cuyuna. The firm's greatest success was in the leasing of the Plymouth mine at Wakefield and its subsequent development by them and Pickands, Mather & Co., who sublet the property from them.

Long before his financial successes Mr. Coates attracted many friends to him by his personality and character. He was extremely philanthropic, giving generously to institutions and people who were in need, and in so quiet a way that they did not know who the giver was. Few in the Lake Superior region have had a wider acquaintance or more friends than he possessed.

He died January 10, 1922.

Martin Goldsworthy.

Martin Goldsworthy was born in Cornwall, England, December 4, 1849. After coming to America he located in Iron Mountain, Michigan, in 1879 and for thirty-six years was employed as miner, shift boss and mining captain at the Chapin mine.

He was a member of the Lake Superior Mining Institute at its first animal meeting in Iron Mountain in 1893 and continued his membership for many years.

He died August 19, 1916.

Nelson P. Hulst.

Dr. Hulst was born in East Brooklyn, New York, February 8, 1842, but spent his boyhood days at Alexandria, Virginia, where he attended, for a part of the time, the Friends School of Caleb Hallowell. When the Civil War commenced, he moved to Montgomery County, Maryland, and later entered Yale College in 1863, graduating in 1867 with B. A. degree, in 1869 with that of Ph. B. and in 1870 with the degree of Ph. D. from the academic and scientific departments of that institution.

In 1870 he entered the employ of the Milwaukee Iron Company in Milwaukee, Wisconsin, as chemist and engineer. In 1872 he visited what is now the Menominee Range, then a wilderness, and in the same year began an exploration at the Breen mine and what is now a part of the Vulcan mine. In 1876 he opened many of the principal mines on the Menominee Range, becoming General Superintendent of the Menominee Mining Company, having at one time charge of the Breen, Vulcan, Norway, Cyclops, Quinnesec, Chapin and Florence mines. On account of ill health he resigned as General Superintendent of the Menominee Mining Company and later opened the Pewabic mine for the Pewabic Mining Company in 1887.

In 1897 he became General Manager for the Oliver Mining Company, then a subsidiary of the Carnegie Steel Company. He was made Vice President in 1901 of the Oliver Iron Mining Company at the time the United States Steel Corporation was formed, retaining this position until 1904, when he retired from active work. On the formation of the Lake Superior Mining Institute in 1893 he was unanimously chosen its first President. He was also a member of many other scientific societies.

His duties required him to visit all the ranges and mining camps of the entire Lake Superior regions, giving him a wide acquaintance with the men in charge and working at the different properties by whom he was greatly admired and respected for his fairness, consideration and just dealing with everyone.

His broad knowledge of the geological formation, mining methods and development of the region commanded the respect and veneration of his associates and his kindly personality and honesty drew to him more admiring

friends than any other individual in the Lake Superior region.

He eked at his Milwaukee home on January 11, 1923.

Amasa Stone Mather.

Amasa Stone Mather was born in Cleveland, Ohio, on August 20, 1884. He was a son of Samuel Mather and Flora Amelia Stone. His father, and also his grandfather, Samuel Livingston Mather, had both been prominent in the iron ore industry for a number of years. He attended University School at Cleveland, graduating from there in 1903, and graduating from Yale College with the degree of B. A. in 1907. After his graduation he made a trip around the world, spending some time in such out of the way places as Formosa, Java, Burma, Bangalore (Southern India), Kashmir (Northern India), and British East Africa.

After his return from his trip around the world he became connected with the firm of Pickands, Mather & Co., taking a position in their iron ore mining department, where his energy and talents brought him to the head of that department. On January 1, 1919, he was admitted as a member of the firm, with high expectations of his assuming a prominent place in the executive management in the firm, which was cut off by his untimely death.

During the early stages of the World War he was active in Liberty Loan and Red Cross work, and in assisting the officials at Washington in the assembling of war materials, being Secretary of the Iron Ore, Coal & Transportation Commission of the Council of National Defense, and later entered the Third Officers' Training Camp at Camp Taylor, Louisville, Kentucky, where lie was at the time of the armistice.

Early in 1920 he was preparing to accompany his father to Europe, his father having been appointed a delegate to the Geneva Peace Conference, when he was seized with an attack of pneumonia, and died on February 9th, within a week after being taken ill. He was survived by his wife, Katherine Hoyt Mather, and two children, Katherine Stone Mather and Samuel Mather II.

Frank P. Mills.

Frank P. Mills was born in Bolivar, Ohio, August 21, 1858, and when about four years of age his parents moved to Ishpeming, Michigan. After receiving his preliminary schooling in the public schools in Ishpeming, he attended Lawrence University, Appleton, Wisconsin, and later went to Stevens Institute of Technology, at Hoboken, New Jersey.

After completing his school studies, Mr. Mills returned to the Michigan iron region, where he spent a number of years in mining work. He was at Stambaugh with the S'tambaugh Iron Company from 1883 to 1885, and with the Illinois Steel Company in Chicago from 1885 to 1887. In the latter year he went to the Cleveland-Cliffs Iron Company, in Ishpeming, as manager of mines, remaining in that capacity until 1895, when he resigned to enter the employ of Godfrey M. Hyams, of Boston. During the years that Mr. Mills was with Mr. Hyams his duties took him to executive mining positions in Colorado, California and West Virginia.

In 1908 Mr. Mills went to Kimberly, Nevada, where until 1913 he was in charge of operations for the Giroux Consolidated Mines Company, and leaving there he went to Berkeley, California, to live. He died in Berkeley, May 18, 1922.

Mr. Mills was married to Miss Mamie Eunson, of Menominee, Michigan, December 26, 1885, and they had three children, Genevieve, Robert and Frank. The first two and Mrs. Mills, survive.

William P. Snyder.

William P. Snyder was born in Holliclaysburg, Pennsylvania, in 1860. At the age of fourteen he was employed as office boy at the Schoenherger Steel Works at Pittsburgh, Pennsylvania.

When still a young man he became a partner in the firm of Leishman & Snyder, iron and steel brokers. This firm dissolved partnership in 1888 and the business was continued under the name of W. P. Snyder & Co., until his death.

Mr. Snyder became interested with others in the development of several properties on the Mesabi Range in the early years of the range, operating the Shenango, Webb and other properties. He was also interested in the Oliver and Snyder Steel Company, the Clairton Steel Company and the Shenango Furnace Company.

It is interesting to note that Mr. Snyder is credited with being the first to use one hundred per cent Mesabi ores in blast furnace practice. He was of vigorous personality and a singularly capable man, a loyal and staunch friend and a benefactor to many who were in need. He died in February, 1922.

PAST OFFICERS.

PRESIDENTS.

Nelson P. Hulst	1893	Thomas F. Cole	1906
J. Parke Channing	1894	Murray M. Duncan	1908
John Duncan	1895	D. E. Sutherland	1909
William G. Mather	1896	William J. Richards	1910
William Kelly	1898	F. W. Denton	1911
Graham Pope	1900	Pentecost Mitchell	1912
W. J. Olcott	1901	W. H. Johnston	1913
Walter Fitch	1902	L. M. Hardenburgh	1914
George H. Abeel	1903	C. E. Lawrence	1915
O. C. Davidson	1904	Charles T. Fairbairn	1917
James MacNaughton	1905	Francis J. Webb	1922

(No meetings were held in 1897, 1899, 1907, 1916, 1918, 1919, 1920 and 1921.)

VICE PRESIDENTS.

1893.

John T. Jones F. P. Mills	J. Parke Channing	Graham Pope M. W. Burt

1894.

John T. Jones F. P. Mills	R. A. Parker	Graham Pope W. J. Olcott

1895.

F. McM. Stanton Geo. A. Newett	R. A. Parker	Per Larsson W. J. Olcott

1896.

F. McM. Stanton Geo. A. Newett	J. F. Armstrong	Per Larsson Geo. H. Abeel

1898.

E. F. Brown James B. Cooper	Edwin Ball	Walter Fitch Geo. H. Abeel

1900.

O. C. Davidson T. F. Cole	M. M. Duncan	J. H. McLean F. W. Denton

1901.

J. H. McLean M. M. Duncan	Nelson P. Hulst	F. W. Denton William Kelly

1902.

William Kelly Nelson P. Hulst	Fred Smith	H. F. Ellard Wm. H. Johnston

1903.

H. F. Ellard Fred Smith	James B. Cooper	Wm. H. Johnston John H. McLean

1904.

H. F. Ellard Wm. H. Johnston	Fred Smith	John H. McLean James B. Cooper

1905.

M. M. Duncan Fred M. Prescott	F. W. McNair	John H. McLean James B. Cooper

1906.

M. M. Duncan J. M. Longyear	Fred M. Prescott	F. W. McNair F. W. Denton

1908.

J. M. Longyear F. W. Denton	David T. Morgan	D. E. Sutherland Norman W. Haire

1909.

W. J. Richards Charles Trezona-	D. T. Morgan	D. E. Sutherland Norman W. Haire

1910.

W. J. Richards John M. Bush	Frederick W. Sperr	Charles Trezona James H. Rough

1911.

E. D. Brigham John M. Bush	Frederick W. Sperr	C. H. Munger James H. Rough

1912.

E. D. Brigham Geo. H. Abeel	W. P. Chinn	C. H. Munger W. H. Jobe

1913.

Geo. H. Abeel Francis J. Webb	W. P. Chinn	A. D. Edwards W. H. Jobe

1914.

Francis J. Webb Charles T. Kruse	Luther C. Brewer	A. D. Edwards Charles E. Lawrence

1915.

G. L. Woodworth G. S. Barber	G. R. Jackson	F. E. Keese T. A. Flannigan

1917.

George L. Woodworth Grant S. Barber	Wm. D. Calverley	Frank E. Keese M. E. Richards

1922.

Wm. D. Calverley M. E. Richards	John E. Hodge	Earl E. Hunner G. R. Jackson

MANAGERS.

1893.

John Duncan Walter Fitch	William Kelly	James MacNaughton Charles Munger

1894.

Walter Fitch John Duncan	M. E. Wadsworth	C. M. Boss O. C. Davidson

1895.

F. P. Mills Ed Ball	M. E. Wadsworth	C. M. Boss O. C. Davidson

1896.

F. P. Mills Ed. Ball	C. H. Munger	Graham Pope William Kelly

1898.

M. M. Duncan J. D. Gilchrist	T. F. Cole	Graham Pope O. C. Davidson

1900.

E. F. Brown Ed. Ball	James B. Cooper	Walter Fitch George H. Abeel

1901.

James B. Cooper James MacNaughton	(One Vacancy)	James Clancey J. L. Greatsinger

1902.

James Clancey J. L. Greatsinger	Amos Shephard	Graham Pope T. F. Cole

1903.

Graham Pope Amos Shephard	W. J. Richards	T. F. Cole John McDowell

1904.

John McDowell Wm. J. Richards	Graham Pope	Thomas F. Cole Amos Shephard

1905.

John C. Greenway John McDowell	William Kelly	H. B. Sturtevant Wm. J. Richards

1906.

John C. Greenway Jas. R. Thompson	William Kelly	H. B. Sturtevant Felix A. Vogel

1908.

James R. Thompson Felix A. Vogel	John C. Greenway	J. Ward Amberg Pentecost Mitchell

1909.

F. E. Keese W. J. Uren	L. M. Hardenburg	J. Ward Amberg Pentecost Mitchell

1910.

Frank E. Keese Charles E. Lawrence	William J. Uren	L. M. Hardenburg William J. West

1911.

Charles E. Lawrence Peter W. Pascoe	J. B. Cooper	William J. West L. C. Brewer

1912.

M. H. Godfrey Peter W. Pascoe	J. B. Cooper	J. E. Jopling L. C. Brewer

1913.

M. H. Godfrey G. S. Barber	Wm. H. Johnston	J. E. Jopling C. H. Baxter

1914.

G. S. Barber W. A. Siebenthal	*Stuart R. Elliott	C. H. Baxter J. S. Lutes

*To fill vacancy of Wm. H. Johnston, elected to presidency.

1915.

F. H. Armstrong Henry Rowe	M. E. Richards	William Wearne Enoch Henderson

1917.

F. H. Armstrong E. S. Grierson	Thomas Hoatson	William Wearne B. W. Batchelder

1922.

Thomas Hoatson B. W. Batchelder	William M. Tappan	John E. Nelson G. E. Harrison

TREASURERS.

C. M. Boss	1893
A. C. Lane	1894
Geo. D. Swift	1895-1896
A. J. Yungbluth	1898-1900
Geo. H. Abeel	1901-1902
E. W. Hopkins	1903-....

SECRETARIES.

F. W. Denton	1893-1896
F. W. Denton and F. W. Sperr	1898
F. W. Sperr	1900
A. J. Yungbluth	1901-....

LIST OF PUBLICATIONS RECEIVED BY THE INSTITUTE.

The Institution of Mining and Metallurgy, Cleveland House, 225 City Road, London, E. C. 1.

American Institute Mining and Metallurgical Engineers, 29 W. 39th St., New York City.

American Society of Civil Engineers, 220 West 57th Street, New York City.

Massachusetts Institute of Technology, Boston, Mass.

Western Society of Engineers, 1734-41 Monadnock Block, Chicago.

The Mining Society of Nova Scotia, Halifax, N. S.

Canadian Mining Institute, Rooms 3 and 4, Windsor Hotel, Montreal.

Canadian Society of Civil Engineers, Montreal.

Institute of Mining Engineers, Neville Hall, Newcastle Upon-Tyne, England.

Chemical, Metallurgical and Mining Society of South Africa, Johannesburg, S. A.

American Mining Congress, Munsey Bldg., Washington, D. C.

State Bureau of Mines, Colorado, Denver, Colo.

Reports of the United States Geological Survey, Washington, D. C.

Geological Survey of Ohio State University, Columbus, O.

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Oklahoma Geological Survey, Norman, Okla.

University of Oregon, Library, Eugene, Oregon.

Case School of Applied Science, Department of Mining & Metallurgy, Cleveland, Ohio.

University of Illinois, Exchange Department, Urbana, Ill.

University of Missouri, Columbia, Mo.

University of Michigan, Ann Arbor, Mich.

University of Colorado, Boulder, Colo.

Columbia University, New York City, N. Y.

University of Pittsburgh, State Hall, Pittsburgh, Pa.

Iowa State College, Ames, Iowa.

Engineering-Contracting, 355 Dearborn Street, Chicago, Ill.

The Excavating Engineer, 267 National Avenue, Milwaukee, Wis.

GENERAL INDEX.

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ARMSTRONG, FRANK H.: *Notes on Some of the Recent Changes in the Equipment of the Republic Mine, Republic, Michigan, Marquette Range,* XI 181, 1906.
ARMSTRONG, FRANK H.: *Electrical Operation of the Plants of the Penn Iron Mining Company, Menominee Range,* XVI 244, 1911.
ARMSTRONG, F. H. and KELLY, WILLIAM: *Use of Electricity at the Penn and Republic Iron Mines, Michigan, Menominee and Marquette Ranges,* XIX 35, 1914.
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ARMSTRONG, RAY W.: *Compound Steam Hoist Installation of the Quincy Mining Company,* XXII 39, 1922.
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Ellard, H. F.: *Sinking and Equipping No. 9 Shaft, Ashland Mine, Gogebic Range,* IX 24, 1903.
Elliott, S. R.: *Athens System of Mining,* XXII 135, 1922.

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ELLIOTT, STUART R.: *Steel Stocking Trestle at No. 3 Shaft, Negaunee Mine, Marquette Range,* XIX 142, 1914.
ELLIOTT, S. R.: *Spies Open-Stope System of Mining,* XXII 113, 1922.
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Equipping and Sinking the No. 1 Shaft at the Holmes Mine, Marquette Range (EATON), XXI 106, 1917.
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LAKE SUPERIOR IRON ORE SHIPMENTS, SEASON 1923.

Summary Compiled from Reports of Lake Superior Iron Ore Association.

Shipments by Ranges (B/L Weights)—

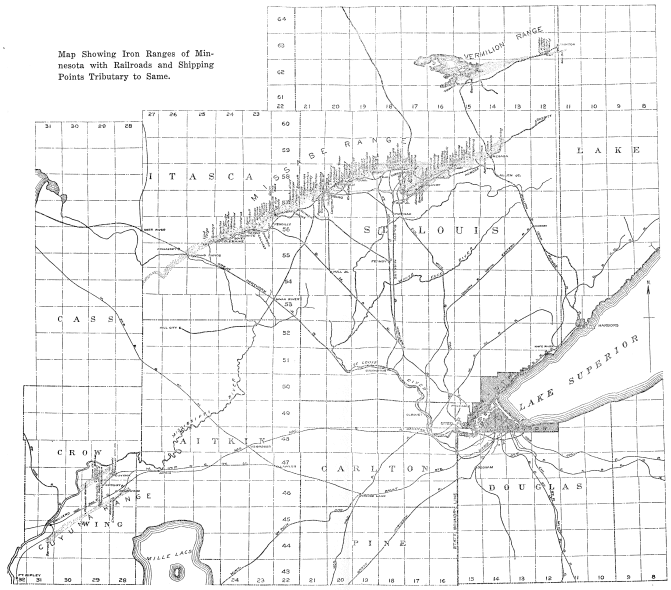
Mesaba	40,731,219
Gogebic	6,177,065
Menominee	4,746,333
Marquette	3,564,411
Cuyuna	2,074,026
Vermilion	1,153,314
Grand total	58,446,368

Shipments from Upper Lake Ports (R. R. Weights)—

Escanaba	5,607,411
Marquette	2,789,285
Ashland	6,237,449
Superior	17,820,476
Duluth	20,163,619
Two Harbors	6,418,464
Total	59,036,704

Receipts at Lake Ports and Furnaces (B/L Weights)—

Lake Erie	43,666,071
Detroit	902,548
Chicago-Gary District	12,613,277
Milwaukee	123,807
Lower Michigan	36,625
Ontario	1,088,155
Total	58,430,483

(Subject to corrections and additions of all-rail shipments.)

[Map of Minnesota Ranges, following]